ORTEC®

DSPEC 50®
DSPEC 502®

Digital Gamma-Ray Spectrometer

Hardware User's Manual

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Advanced Measurement Technology, Inc.
("AMT")

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ADDITIONAL WARRANTY STATEMENT

Please note that the integrated computer that controls the ORTEC® DSPEC 50® is intended exclusively for the tasks detailed in this operation manual. Using this computer for any other purpose ***may void your warranty.***

In addition, the DSPEC 50 contains ***no user-serviceable parts.*** Breaking the seal on the case ***voids your warranty.*** The DSPEC 50 should be opened only by ORTEC-authorized service personnel.

If you have any questions about the use or maintenance of this instrument, please contact your ORTEC representative or our Global Service Center first.

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Safety Instructions and Symbols

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

CAUTION Indicates a hazard that could result in property damage if the safety instruction is not observed.

In addition, the following symbols may appear on the product:

DANGER – Hazardous voltage

ATTENTION – Consult the manual in all cases where this symbol is marked in order to determine the nature of the potential hazards and any actions that must be taken to avoid them

Protective earth (ground) terminal

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

Cleaning Instructions

To clean the instrument exterior:

- Disconnect the instrument from the power source.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

CAUTION	To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.

ORTEC®
AMETEK®
% of preset
Dead time %
Input count rate
LT = 87.1
Now
3/10/2011
3:34:33 PM
DT = 20.5%
Started
3/10/2011
3:34:14 PM
CRM = 5755
DSPEC 50®
ORTEC®
50 YEARS
OF INNOVATION

1. INTRODUCTION

The DSPEC 50® marks a half-century of continuous development of nuclear instruments by ORTEC®. This is a high-quality implementation of digital signal processing techniques in an integrated gamma spectrometer, designed for use with high-resolution, high-purity germanium (HPGe) detectors.[1] Whether your application is in nuclear power, non-destructive analysis, research physics, homeland security, real-time monitoring, or nuclear safeguards, the DSPEC 50 and the dual-input DSPEC 502® deliver exceptional ease of use, flexibility, and rock-solid count rate and peak position stability, across an Ethernet or USB connection. The color touchscreen lets you monitor key aspects of instrument status and data acquisition at a glance, without referring to your computer.

As befits such a landmark instrument, the DSPEC 50[2] is packed full of ORTEC's premier performance-enhancing technology and user-beneficial features.

- Superior-performance digital circuitry with low-noise internal power supplies and detector bias gives you the best possible system resolution performance.
- The all-metal enclosure provides a high degree of isolation from electrical noise. It fits on the benchtop or on a shelf in a 19-inch rack.
- Highly stable performance in the presence of temperature and count-rate variation.
- Wide-ranging digital filter settings with automated optimization.
- Ethernet (RJ45) interface for simple network connection, and USB or Ethernet interface for use on the host computer.
- Connects to ORTEC SMART-1™ and DIM detectors, and to detectors with conventional connectors.
- The large, color touchscreen provides the TCP/IP connectivity interface; and displays status readouts including the preset count conditions, current live- and dead-time percentage (if active), input count rate, HV status, and optional gain- and zero-stabilizer correction. The DSPEC 502 screens are labeled MCA-1 and MCA-2 so you can easily tell which input is onscreen.
- ORTEC's formidable suite of enhancements to help achieve optimum system performance, including Ballistic Deficit Correction, Charge Trapping Correction, the Low-

[1]Sodium iodide detectors, connected via the ORTEC DIM-POSNAI detector interface module, can also be used.

[2]Hereinafter, except as noted, "DSPEC 50" refers to both the DSPEC 50 and DSPEC 502.

Frequency Rejector, the data Throughput Enhancer, ZDT™ Mode zero-dead-time counting, and List Mode. These are discussed in detail in the remainder of this chapter.

ORTEC CONNECTIONS software supports an essentially unlimited number of Ethernet- or USB-connected DSPEC 50s. In addition, almost any combination of other ORTEC multichannel buffers[3] (connecting via Ethernet, USB, printer port, Dual-Port Memory Interface, etc.) can be connected to the same system.

1.1. DSPEC-Family Technologies for HPGe Systems

Resolution Enhancer In ORTEC DSPEC products, the flattop width parameter of the trapezoidal filter automatically corrects for ballistic deficit (Section 1.2). Unfortunately, this doesn't compensate for resolution loss due to charge trapping, which results in variations in charge collection efficiency over the crystal volume. The DSPEC 50 uses our Resolution Enhancer, which enables you to correct for charge trapping by "training" the spectrometer to accommodate the particular performance of your detector. See Section 1.3.

Enhanced Throughput Mode This signal processing method allows the spectrometer to begin sampling the next pulse before the preceding one has returned to baseline. The effect is optimum throughput while maintaining resolution and peak shape. See Section 1.4.

Low-Frequency Rejector (LFR) Filter Our Low-Frequency Rejector[4] digital filter surpasses all signal processing methods for reducing the effects of microphonics, ground loops, and virtually all other sources of periodic noise for HPGe and NaI(Tl) spectrometry. See Section 1.5.

Zero Dead-Time Correction[5] The DSPEC 50 features our innovative ZDT™ mode of operation, an alternative to the classical "extended-live-time clock." The ZDT method produces accurate results in *all* situations and completely overcomes some of the shortcomings of extended live-time methods. Moreover, the new ZDT method overcomes some limitations in previous "loss-free" dead-time correction methods. Most notably, the ZDT mode does not require any manual adjustments and is capable of computing the statistical uncertainty of the corrected spectrum. See Section 1.6.

SMART-1® Support Detectors equipped with the SMART-1 technology have their recommended bias values preset at the factory. No more shuffling through paperwork or looking for

[3]We use the term "multichannel buffer" (MCB) to indicate a multichannel analyzer (MCA) with enhanced features and data memory.

[4]Patent pending.

[5]Patent number 6,327,549.

tags on the detector to find the right bias setting. Simply turn on the electronics and the SMART-1 detector senses the detector temperature and applies the right high-voltage bias. These detectors allow modern instruments like the DSPEC 50 to monitor and display detector state of health (SOH) during acquisition, including detector temperature, preamplifier power, bias overrange, and bias on/off state. This continuous SOH monitoring ensures the integrity of the acquired data. A quick check of the SOH flag in the SMART-1 detectors shows if any parameter deviated from specification during the measurement. This is vitally important for environmental samples that must be counted for long periods of time and regulatory-driven samples where chain-of-custody integrity means everything.

List Mode In List Mode, the DSPEC 50 records and stores the pulse value with a time-stamp for every pulse generated by the detector. With List Mode, you can write your own programs that can reconstruct histograms for any time segment without dead time between histograms, or make histograms for overlapping time slices. Data can be stored easily for reconstruction of any time frame needed. In addition, MAESTRO v7 supports our List Mode MCBs with menu and toolbar commands, as well as commands in our automated JOB streams. If your application requires *real* real-time monitoring, no other instrument comes close for HPGe applications. See Appendix E.

Sample Changer Connections and Controls The DSPEC 50 connects easily to many types of automatic sample changer.

Standard DSPEC-Family Features The DSPEC 50 also offers the InSight™ Virtual Oscilloscope, which allows you to optimize detector performance for a given application from the computer; our easy automatic pole-zero adjustment[6] and automatic baseline restorer[7]; and the highly accurate Gedcke-Hale extended live-time correction method.[8]

1.2. Ballistic Deficit and Adjusting the Flattop Duration

In germanium detectors it takes a variable amount of time to collect all of the charge released in the detector diode when a gamma ray deposits energy in the detector. The duration of this charge collection time depends on the dimensions of the detector, the geometry of the electrodes, and the points at which energy is deposited in the detector. A small, planar detector has charge collection times that vary from 50 ns to 100 ns, whereas a large coaxial detector is characterized by charge collection times that vary from 100 ns to 700 ns. The variability of the charge collection

[6]Patent number 5,872,363.

[7]Patent number 5,912,825.

[8]Ron Jenkins, R. W. Gould, and Dale Gedcke, *Quantitative X-Ray Spectrometry* (New York: Marcel Dekker, Inc.), 1981, pp. 266–267.

time within a specific detector is the source of the resolution degradation described by the *ballistic deficit effect*.

The ballistic deficit becomes a significant source of resolution degradation when very short shaping times are selected in order to reduce dead time and improve the high counting-rate limit. For a digital filter having the shape of a symmetrical triangle in the time domain, the output pulse begins to rise as soon as the gamma ray is detected. It continues to rise until it reaches a peak amplitude at a time specified by the currently selected rise/fall time (this is the **Rise Time** parameter entered on the Amplifier 2 tab under **Acquire/MCB Properties...**; see Section 4.2). Beyond this peak-amplitude time, the pulse falls back to the baseline to allow a subsequent gamma ray to be processed. If all the charge has not been collected by the detector by the designated time for peak amplitude, there will be a deficit in the measured peak amplitude and a broadening of the pulse width. The deficit in amplitude is called the *ballistic deficit*. Obviously, events that result in a faster charge collection time will suffer less deficit and less increase in pulse width than those yielding a slower charge collection time, even though the deposited energy was identical. Thus, the ballistic deficit resulting from variable charge collection times broadens the energy resolution for that gamma ray.

If the longest charge collection time is negligible compared to the rise time of the filter pulse, the ballistic deficit will be imperceptible, and the energy resolution will not be degraded. Thus, at the 10- to 20-μs rise times typically selected for optimum signal-to-noise ratio (i.e., minimum peak FWHM at low energies) the ballistic deficit problem can be ignored.

Long rise times create higher dead times and depress the maximum counting-rate limit. If it is necessary to accept higher counting rates, the rise/fall times must be shortened accordingly. For this case, the DSPEC 50 includes a flattop feature for the filter that can eliminate the resolution broadening caused by ballistic deficit. Instead of a symmetrical triangle with a sharp point at the peak amplitude, the rising and falling edges are separated by a flattop to form a trapezoid. The width of the flattop is adjusted to be long enough to match the longest charge collection time for the detector employed. This allows time for the longer-charge-collection pulses to reach the same maximum pulse amplitude as the faster-charge-collection pulses from gamma rays of the same energy. Consequently, the effect of ballistic deficit is reduced, and the energy resolution is dramatically improved at these short pulse widths.

Note that the selection of shorter pulse widths inevitably degrades the signal-to-noise ratio compared to the optimum achieved at longer pulse widths. Thus, operating at shorter pulse widths will compromise the energy resolution of low-energy gamma rays, for which the preamplifier noise makes a significant contribution to the energy resolution. The signal-to-noise degradation is independent of the ballistic deficit effect.

The flattop and other shaping controls are on the Amplifier 2 tab under **Acquire/MCB Properties...**; see Section 4.2 for a more detailed discussion.

1.3. Resolution Enhancer Corrects for Charge Trapping

When a gamma ray interacts with a germanium detector, mobile electrons and holes are generated. The electrons and holes are swept to the detector electrodes by the electric field inside the detector. If all the electrons and holes travel the complete path to the detector electrodes, a signal is produced proportional to the energy deposited in the detector by the gamma ray. If some of the electrons or holes do not reach the electrodes, the signal produced will be smaller than expected. The process of interrupting the movement of an electron or hole is referred to as "charge trapping."

If charge trapping did not occur, the resolution of a reasonably low-noise germanium detector for the 1.33-MeV gamma ray from ^{60}Co would be about 1.5 keV FWHM. Real detectors typically have a resolution of 1.8 to 2.2 keV FWHM. ORTEC's Charge Trapping Corrector (CTC) helps reduce this energy resolution loss caused by charge trapping, yielding the DSPEC 50's *Resolution Enhancer Mode*. The controls are accessed via the **Acquire/MCB Properties...** command in the accompanying MAESTRO® Multichannel Analyzer Emulation Software (A65-BW) and other ORTEC CONNECTIONS compliant software packages.

Charge trapping is caused by various defects and impurities in the germanium crystal, and thus varies from detector to detector. The amount of charge lost due to trapping also depends on the distance the charge carrier (electron or hole) has to move to reach the collecting electrode. If the carrier must travel a long distance, it is more likely to be trapped. If some of the charge is trapped, it does not contribute to the signal. The reduced signals have a different rise time than the full signals. The relationship between rise time of the signal and charge trapping is the basis of the Charge Trapping Corrector.

The digital filter in the DSPEC 50 measures the amount of charge collected for each event and uses the result to increment the spectrum memory location associated with that charge measurement. The Charge Trapping Corrector also measures the pulse rise time for the event. The pulse rise time is used to adjust the very fine gain. For each pulse, the measured charge is increased by the appropriate fine gain factor to correct for the signal lost due to carrier trapping.

1.4. Enhanced Throughput Mode

To optimally process an input pulse stream, and thereby obtain the best spectral resolution, the signal processing device should allow the input signal to return to baseline before beginning to process the subsequent pulse. However, in cases where some loss of resolution is acceptable, it is possible for a DSP to begin processing a subsequent pulse before the first pulse has returned

to the baseline, *provided the first pulse has returned to baseline when the peak-detect of the second pulse occurs*.

The ORTEC *Enhanced Throughput Mode* takes advantage of this feature of digital signal processing by allowing you to adjust the delay between the peak-detect and the start of processing of the next pulse. The dead time for a conventionally processed pulse is the sum of the pulse's rise time, flattop, and fall time. By contrast, the dead time in ORTEC's Enhanced Throughput Mode can be as little as the rise time plus the flattop. These two scenarios are illustrated in Fig. 1. The DSPEC 50 lets you set a *protection time* (PT), following a peak-detect, that blocks subsequent peak-detects until the protection time has elapsed. Note that the conventional dead time illustrated in Fig. 1 is the same as the maximum protection time in Enhanced Throughput Mode.

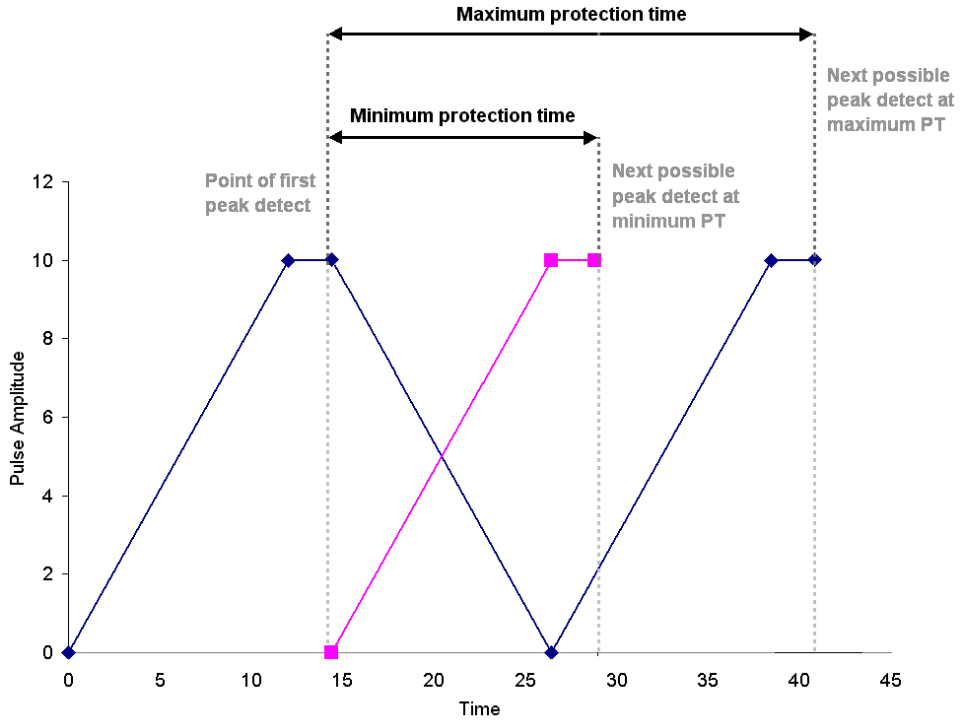


Figure 1. Demonstration of the DSPEC 50's Minimum and Maximum Protection Times in Enhanced Throughput Mode. At the maximum protection-time setting, the DSPEC 50 processes pulses in the conventional way.

The protection-time settings with the low-frequency rejector (LFR) filter *off* range between:

- Minimum PT (highest throughput) = *(1 × rise time) + (1 × flattop)*
- Maximum PT = *(2 × rise time) + (1 × flattop)*

With LFR *on*, the protection-time settings range between:

- Minimum PT = *(3 × rise time) + (2 × flattop)*
- Maximum PT = *(6 × rise time) + (3 × flattop)*

1.5. The Low Frequency Rejector (LFR) Filter

In designing an MCB that can be used in conjunction with mechanical coolers, ORTEC has developed a new digital filter, the Low Frequency Rejector (LFR) filter, capable of correcting the pulse output signal for changes in the baseline caused by cooler-induced microphonics. In many ways digital filters are easier to understand than their analog counterparts. Figure 2 shows the voltage step output produced at the preamplifier by the collection of charge produced by absorption of a gamma-ray and the resulting trapezoidal weighting function in a digital spectrometer. The difficulty in the measurement is to precisely determine the height of the step pulse because the baseline contains noise. A fairly obvious estimate of the step signal is obtained by averaging the digitized samples of the signal before and after the step. M samples immediately after the event are first ignored, to allow for a maximum rise time of M times the sample interval. N samples of the baseline prior to the step pulse are averaged and then subtracted from the average of N samples taken after the step pulse. This simple procedure produces a trapezoidal weighting function with a rise time of N sample intervals and a flattop of M sample intervals. The maximum value of the trapezoid output, occurring at the end of the flattop, is the best estimate of the step height and therefore the gamma-ray energy. With a proper selection of M and N, this filter is very nearly the optimum filter for a system with noise arising only from the detector leakage (parallel noise) and the FET current (series noise).

The trapezoidal filter is essentially independent of dc offsets, since the averaging and subtracting removes the dc component of the signal. Unfortunately, it is just as sensitive as analog filters to slowly varying signals such as those produced in microphonic noise. Figure 2 shows the output of the trapezoidal filter is equal to the slope of the baseline signal multiplied by the full width at half maximum (FWHM) of the trapezoid. If a step pulse were to be measured on such a baseline, the filter output value would be too great by an error equal to the difference between the average values A1 and A2. Since the microphonic noise component in a signal is approximately a sine wave, as illustrated in Fig. 3, the error induced can be positive, negative, or zero. This error signal adds to the width of the spectral lines, appearing as degraded resolution performance from the detector, and can in many cases be a dominant noise source, especially at lower energies.

The ORTEC LFR filter removes most of the microphonic noise by estimating the microphonic-induced error signal on a pulse-by-pulse basis and subtracting the estimated error signal from the trapezoid output. As noted above, the error signal is proportional to the slope of the baseline during the energy measurement. If the slope is known, then so is the error introduced by the micro-

phonics. An excellent estimate of the slope can be obtained by using the trapezoidal filter itself to measure the slope both before and after the energy measurement. Since the digital filter is always sampling the input signal, it is only necessary to store (1) the values measured before the event is detected, (2) the gamma-ray energy measurement, and (3) the values measured after the event is detected. The modified trapezoidal digital filter for LFR from an InSight Virtual Oscilloscope trace is shown in Fig. 4.

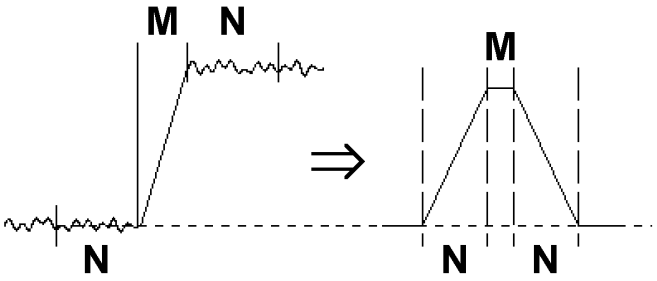


Figure 2. Typical Trapezoidal Weighting Function (right) Arising from Detector Preamplifier Output Signal (left).

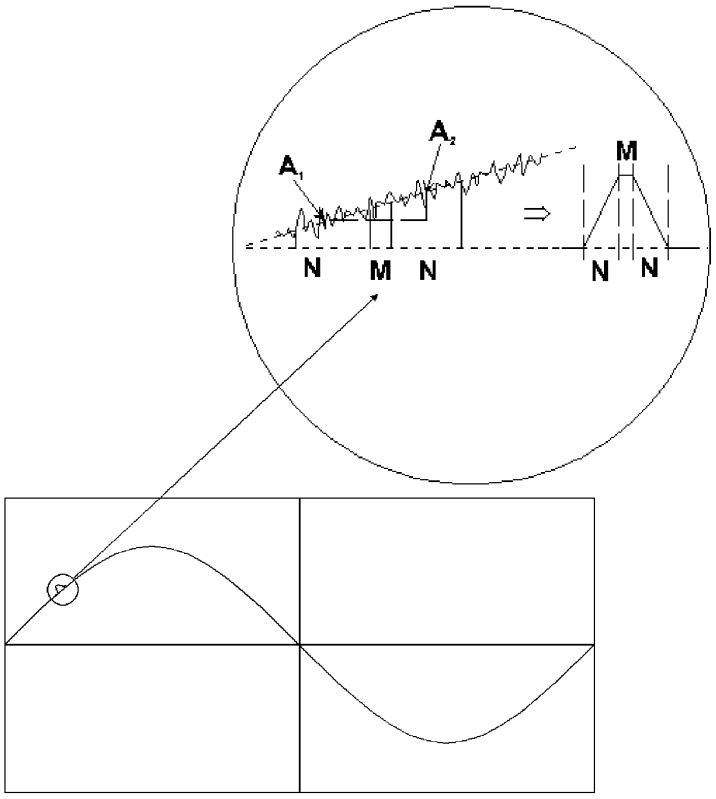


Figure 3. Example of Weighting Function Output Resulting from the Positive Slope Due to Low-Frequency Noise (shown as a sine wave).

A suitably weighted and averaged value of the before and after slope measurement is then subtracted from the energy measurement producing a measurement essentially free of microphonic noise. Although the inherent increase in the pulse processing time increases the dead time of the system, the resolution can be greatly enhanced when periodic noise is present.

To switch to LFR mode, click the Amplifier PRO tab under **Acquire/MCB Properties...**, and mark the **Low Frequency Rejector** checkbox (see Section 4.3). Note that you ***cannot*** optimize or pole-zero the DSPEC 50 while in LFR mode. The Optimize feature should be used with the LFR filter off (checkbox unmarked). Subsequent measurements can then be taken with the LFR filter on.

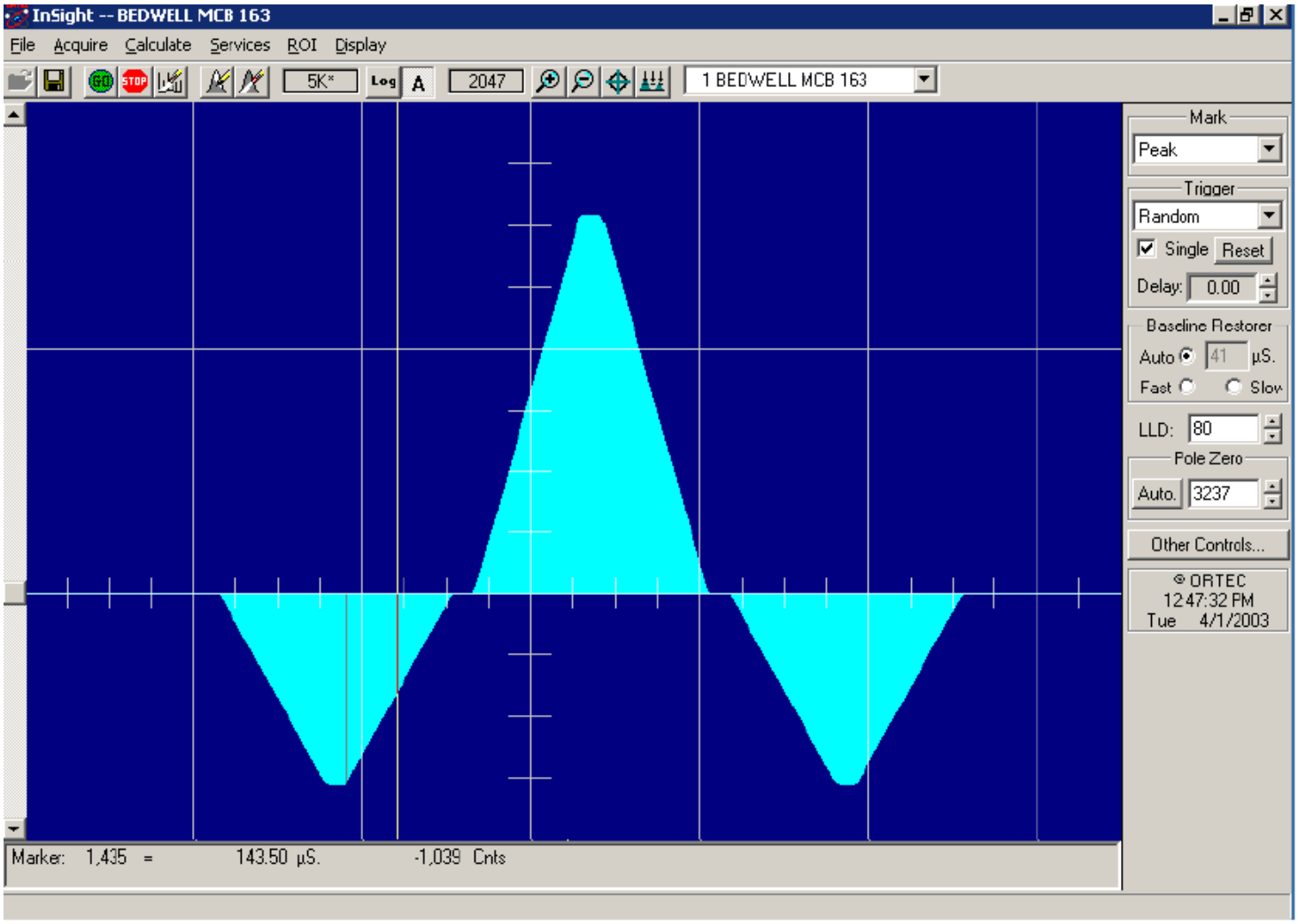


Figure 4. LFR-Enabled Digital Filter.

1.6. Zero Dead-Time (ZDT) Mode

An *extended live-time clock* increases the collection time (real time) of the acquisition to correct for input pulse train losses incurred during acquisition due to system dead time. This corrected time value, known as the live time, is then used to determine the net peak count rates necessary to determine nuclide activities.

As an example, consider the case where the spectrometry amplifier and ADC are 60% dead during the acquisition. the elapsed real time will be:

$$Real\ Time = \left(\frac{Live\ Time}{1 - 0.60} \right)$$

$$= \left(\frac{Live\ Time \times 100\%}{100\% - \%\ Dead\ Time} \right)$$

If the *N* counts in the gamma-ray peak in the spectrum are divided by the elapsed live time, the resulting counting rate, $N / Live\ Time$, is now corrected for dead-time losses. The standard deviation in that counting rate is $\sqrt{N} / Live\ Time$.

Unfortunately, extending the counting time to make up for losses due to system-busy results in an incorrect result *if the gamma-ray flux is changing as a function of time*. If an isotope with a very short half-life is placed in front of the detector, the spectrometer might start out with a very high dead time, but the isotope will decay during the count and the dead time will be zero by the end of the count. If the spectrometer extends the counting time to make up for the lost counts, it will no longer be counting the same source as when the losses occurred. As a result, the number of counts in the peak will not be correct.

When a supported ORTEC MCB operates in ZDT[9] mode, it adjusts for the dead-time losses by taking very short acquisitions and applying a correction in ***real time*** — that is, as the data are coming in — to the number of counts in the spectrum. This technique allows the gamma-ray flux to change while the acquisition is in progress, yet the total counts recorded in each of the peaks are correct. The resulting spectrum has no dead time at all — in ZDT mode, the *data* are corrected, not the acquisition time. Thus, the net counts in a peak are divided by the real time to determine the count rate.

ZDT mode has a unique feature in that it can store both the corrected spectrum and the uncorrected spectrum, or the corrected spectrum and the uncertainty spectrum. Therefore, supported MCBs allow you to choose between three **ZDT Mode** settings on the ADC tab under **MCB Properties...**: **Off**, **NORM_CORR**, and **CORR_ERR**.

Table 1 shows which spectra are collected in the three possible ZDT modes.

1.6.1. Off — Uncorrected Spectrum Only

In this mode, only the uncorrected spectrum (live time and real time with dead-time losses) — also called the *live-time-corrected* or *LTC* spectrum — is collected and stored in the `.SPC` file. The LTC spectrum can be used to determine exactly how many pulses at any energy were

[9]Patent number 6,327,549.

Table 1. ZDT Modes.

Mode	Uncorrected Spectrum	ZDT Corrected Spectrum	ZDT Error Spectrum
Off (ZDT Disabled)	Yes	No	No
NORM_CORR (ZDT–LTC Mode)	Yes	Yes	No
CORR_ERR (ZDT–ERR Mode)	No	Yes	Yes

processed by the spectrometer. The corrected spectrum gives the best estimate of the total counts that would have been in the peak if the system were free of dead-time effects. The uncertainty spectrum can be used to calculate the counting uncertainty, channel by channel, in the corrected spectrum.

NOTE When the spectrometer is placed in ZDT mode, the throughput of the instrument is reduced somewhat as extra processing must be done on the spectrum; therefore, if the gamma-ray flux is not changing as a function of time, but absolute highest throughput is desirable, you might wish to store only the LTC spectrum in the MCB memory.

1.6.2. NORM_CORR — ZDT and Uncorrected Spectra Stored

When the ZDT mode is set to **NORM_CORR**, the two spectra stored are the LTC spectrum and the ZDT spectrum (corrected for the dead-time losses; real time only). Unfortunately, in the analysis of the ZDT spectrum, the uncertainty of the measurement cannot be determined using either spectrum.

NOTE This mode is not useful for quantitative analysis if the counting rate varies significantly during the measurement time, particularly if the user desires an accurate counting rate and standard deviation calculation. *When you select the NORM_CORR mode, ORTEC spectroscopy applications such as GammaVision® and ISOTOPIC ignores the ZDT spectrum and analyzes the LTC spectrum as it would for the **Off** ZDT mode.*

1.6.3. CORR_ERR — ZDT and Error Spectra Stored

In the **CORR_ERR** mode, the estimation of the statistical uncertainty is stored in place of the LTC spectrum, and is referred to as the *error spectrum* (ERR). In this mode, the ZDT spectrum is used to measure the counts in a peak, and the error spectrum is used to determine the uncertainty of the measurement made in the corrected spectrum.

For example, if the area of a peak is measured in the corrected spectrum by summing channels 1000 to 1100, the variance of the measurement can be determined by summing the counts in channels 1000 to 1100 in the error spectrum. Or, shown another way, the counts in channel *i* can

be expressed as $N(i) \pm \sqrt{V(i)}$ with a 1-sigma confidence limit, where *N* is the corrected spectral data and *V* is the variance (error) spectral data.

The live time is set to the real time within the analysis engine during the analysis of ZDT spectra.

A **CORR_ERR** spectrum is analyzed[10] as a regular spectrum most of the time, with a few exceptions as listed below.

- To calculate the peak area uncertainty, the error spectrum is used. If the peak limits are from *L* and *H* channels, then the background variance is calculated as:

$$B_{var} = \frac{(B_1/n_1/n_1 + B_2/n_2/n_2)}{4} \times (H - L + 1)^2$$

  where:
  - B_1 = sum of background counts for the channels adjacent to the peak start (low-energy) channel *L*
  - B_2 = sum of background counts for the channels adjacent to the peak end (high-energy) channel *H*
  - n_1 = the number of low background points (n_1 = 1, 3, or 5) used
  - n_2 = the number of high background points (n_2 = 1, 3, or 5) used

  The peak area uncertainty is calculated from:

$$\sigma = \sqrt{G + B_{var}}$$

  where G is the sum of counts, from the error spectrum, from channels *L* to *H*.

$$\%\ error = \frac{\sigma\ (from\ error\ spectrum)}{Area\ (from\ ZDT\ spectrum)} \times 100$$

- In our WAN and ISOWAN analysis engines, the peak-fitting routine fits all the library peaks as singlets to calculate the peak centroid, peak start and end channels, and peak background. A linear background under the peak is assumed during the peak fitting process.

[10]Using our gamma-ray spectrum analysis software such as GammaVision® or ISOTOPIC.

- The error spectrum is always used to calculate the uncertainties of counts whenever needed. For example, if peak deconvolution is needed, the error spectrum is used to find the best fit for the peak background.

1.6.4. Choosing a ZDT Mode

When the counting rate is essentially constant during the time required to acquire the spectrum, the standard mode — **ZDT Off** — is the preferred mode; only the uncorrected spectrum is collected and stored in the spectrum file. But, if the counting rate varies significantly during the measurement time, the standard mode will not yield the proper dead-time-corrected counting rate. This can be most easily understood by noting that the uncorrected mode compensates for dead-time losses by extending the real counting time. Hence a sample containing both a short-lived high-activity isotope and a long-lifetime lower-activity isotope will experience very high dead-time losses during the first few seconds of the measurement, as the short-lifetime isotope decays rapidly. This high dead time will cause the counting time to be extended after the short-lived isotope has decayed to zero activity, and the system will count the low-activity isotope for the extra time. Consequently, the average activity of the short-lived isotope will be under-estimated.

If you anticipate significantly varying counting rates during the time taken to acquire the spectrum, the **CORR_ERR** ZDT mode should be used. The **CORR_ERR** mode corrects for dead-time losses over minuscule time intervals by adding counts to the ZDT spectrum in proportion to the instantaneous ratio of real time to live time. Thus, the dead-time correction can correctly track rapidly changing counting rates. The **CORR_ERR** mode should be used whenever the counting rate might change significantly during the measurement time. In addition to the rapidly-decaying isotope example above, the **CORR_ERR** mode should be used when monitoring cooling water flow from a nuclear reactor. The **CORR_ERR** mode accommodates brief bursts of high-activity in the water flowing past the gamma-ray detector. Both the corrected and error spectra are stored in the resulting spectrum file.

Note that the counts in the ZDT spectrum must be divided by the elapsed REAL time to compute the dead-time corrected counting rate. It is important to note that the standard deviation in the N_{ZDT} counts in a gamma-ray peak in the ZDT spectrum is not $\sqrt{N_{ZDT}}$. Instead the standard deviation is obtained from the N_{ERR} counts in the same peak ROI in the accompanying error spectrum. The standard deviation in this case is $\sqrt{N_{ERR}}$. And the standard deviation in the computed counting rate, $\sqrt{N_{ZDT}} / Real\ Time$, is $\sqrt{N_{ERR}} / Live\ Time$.

1.6.4.1. The NORM_CORR Diagnostic Mode

Why is there a **NORM_CORR** mode, and why should you avoid using it? This mode simultaneously collects the ZDT spectrum and the conventional uncorrected spectrum. It is useful for demonstrating that the counts in the uncorrected spectrum divided by the live time is the same counting rate as the counts in the ZDT spectrum divided by the real time, in the special case of constant counting rate. Because the error spectrum is not collected in **NORM_CORR** mode, the standard deviation in the ZDT counts cannot be calculated if the counting rate is varying. GammaVision and ISOTOPIC provide some protection for users if the **ZDT-LTC** mode is inadvertently selected. In this case, ISOTOPIC ignores the ZDT spectrum and presumes you intended to use the uncorrected spectrum in a constant-counting-rate application.

1.6.4.2. To Summarize

- Use the ZDT **Off** mode when the counting rate is expected to be constant during the time taken to acquire the spectrum.
- Use the ZDT **CORR_ERR** mode when the counting rate is expected to change or might change significantly during the time required to acquire the spectrum.
- Avoid using the **NORM_CORR** mode because ISOTOPIC v4 will default to analyzing the LTC spectrum and will ignore the ZDT spectrum.

More Information

For more detailed information, contact your ORTEC representative or go to our website at www.ortec-online.com.

- Application note AN56, "*Loss Free Counting with Uncertainty Analysis Using ORTEC's Innovative Zero Dead Time Technique.*"
- General gamma spectroscopy technical papers in our online publication Library.

1.7. Host Computer and Software Requirements

The DSPEC 50 operates on any computer running under Microsoft® Windows® 8, 7, or XP Professional SP3. It requires CONNECTIONS v7.02.03 or higher, and an ORTEC spectroscopy application such as the supplied MAESTRO MCA Emulation Software, v6.08 or higher.

1.8. About This Manual

This manual describes the DSPEC 50 including its touchscreen interface and communication configuration, tells how to connect it in a complete spectroscopy system, gives instructions on configuring the hardware settings (such as high voltage, presets, and gain), and supplies the firmware commands and responses. Complete details on using the control software are in the accompanying MAESTRO *Software User's Manual* as well as the manuals for GammaVision®, ISOTOPIC, and our other integrated MCA emulator/analysis software.

NOTE Except as noted, when we refer to MAESTRO in this manual, we mean the ORTEC MCA emulator or spectrum analysis application you are using (i.e., MAESTRO, GammaVision, ISOTOPIC, etc.).

[Intentionally blank]

2. THE DSPEC 50

This chapter discusses the front panel power switch and touchscreen interface (Section 2.1); and the rear-panel connectors (Section 2.2).

2.1. Front Panel

Figure 5 shows the DSPEC 50 front panel, which includes the ON/OFF rocker switch and the 800 × 480 pixel color touchscreen.

Figure 5. The DSPEC 50.

2.1.1. The ON/OFF Switch and Power-Up

On power-up, the DSPEC 50's integrated computer initializes and automatically starts the DSPEC 50 software application at the *Switchboard* screen (discussed below). This typically takes 20–30 seconds.

2.1.2. The Touchscreen Interface

The touchscreen interface includes:

- The *Switchboard* screen, from which you can open two control screens and four data display screens. The DSPEC 502 Switchboard displays *two* banks of four data display screens, one per MCA; this is shown in Fig. 6.

  — To view a control or data display screen, tap its thumbnail. It will remain displayed until you manually return to the Switchboard. To return from a control screen, tap **Apply**. To return from a data display screen, tap anywhere on the screen.

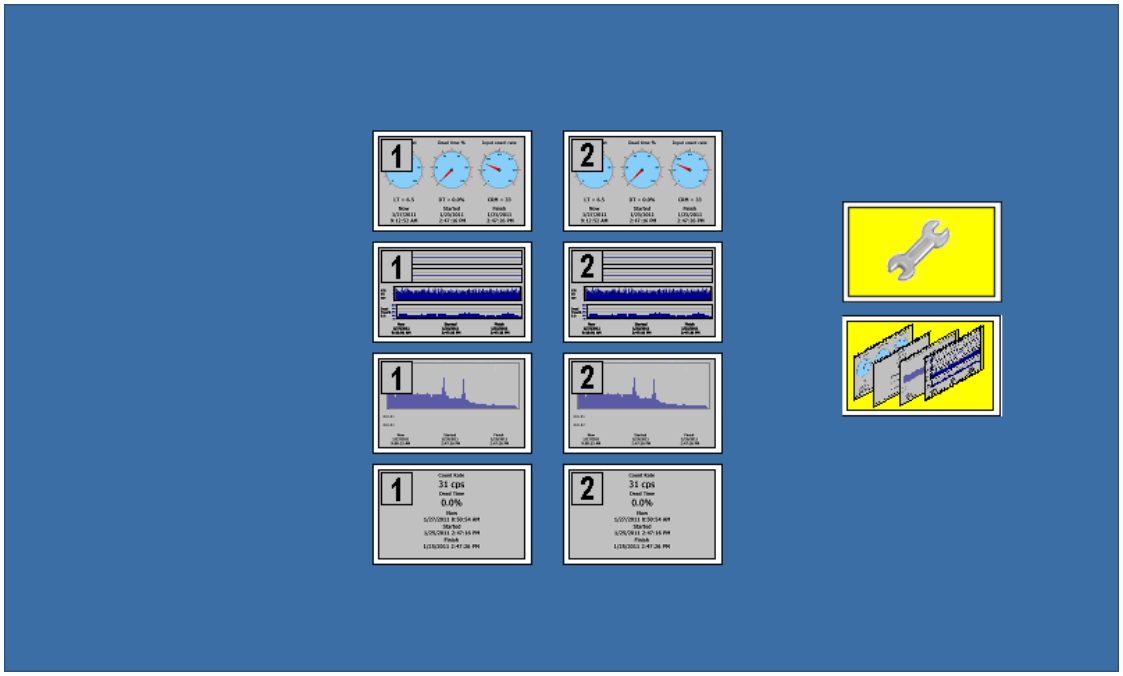
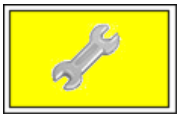


Figure 6. The DSPEC 502 Switchboard (showing the two banks of data display thumbnails for MCA-1 and MCA-2).

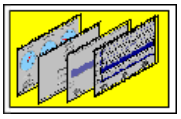
— If the Switchboard is displayed for >5 seconds, it begins cycling through the four (or two sets of four) data display screens[11] (see Section 2.1.3).

- Two interactive *control* screens:

  — **Communication Control** Use this screen to change how the data and time are displayed, assign a password to limit access to this screen and the Display Control screen; and assign static IP addresses to multiple DSPEC 50s where required (typically not necessary); see Section 2.1.4.



  — **Display Control** (**Status Setup**) This screen controls the display, display order, and display interval of the touchscreen graphics; see Section 2.1.3.



- Four *data display* screens (per MCA; i.e., two banks of four for the DSPEC 502) that provide real-time system and data acquisition status. These allow you to monitor several key data acquisition parameters at a glance, without referring to the computer. The four data display screens — **Gauges**, **Chart**, **Spectrum**, and **Big Numbers** — are discussed in Section 2.1.5.

[11]Plus any user-added images; see page 19.

2.1.3. The Display Control Screen (Status Screen Setup)

Tapping the yellow “multi-screen” thumbnail opens the screen shown in Fig. 7, which allows you to display or hide the four data display screens and up to nine .JPG-format images of your choice; control the display order of the images; determine the display interval; and import .JPG images via the rear-panel SD slot.

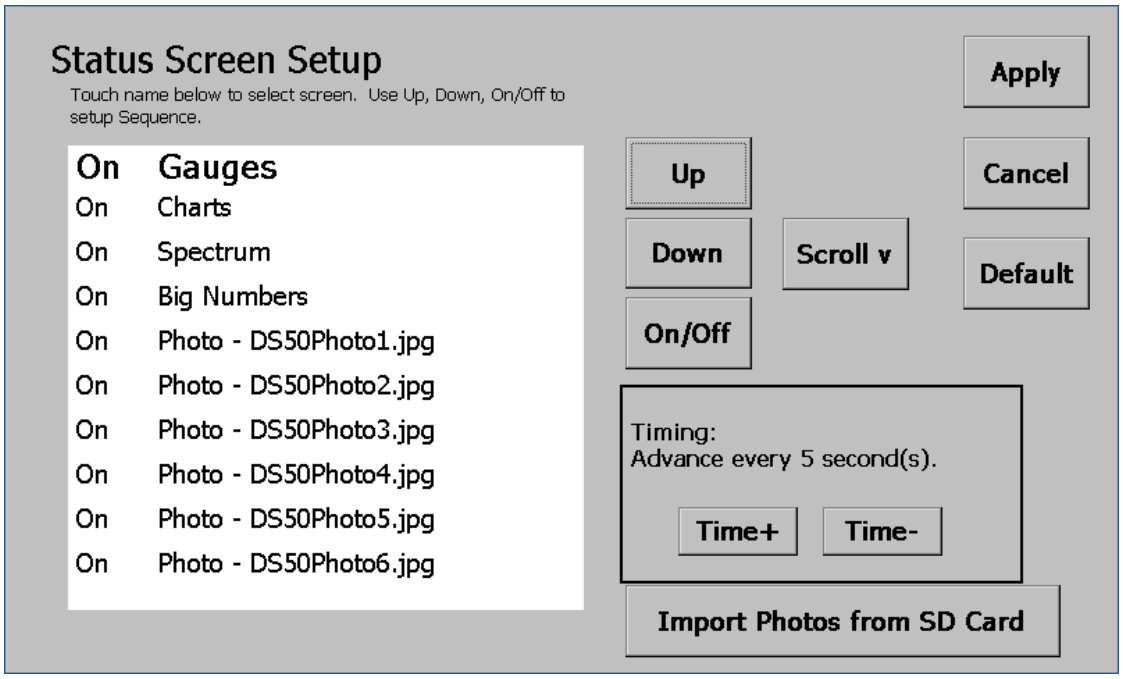


Figure 7. Control The Display of Status Screens.

To turn a screen on or off, tap its name (the name will enlarge), then tap the **On/Off** button. To change a screen’s display order, tap it, then tap the **Up** and **Down** buttons as needed to reposition it. Tap **Scroll** to move up and down through the list of screens. Tap **Time+** and **Time−** to change the screen display interval.

The DSPEC 502 has two sets of the four data display screens, identified here with a suffix of MCA-1 or MCA-2.

Tap **Apply** to accept any changes and return to the Switchboard. Tap **Cancel** to return to the Switchboard without any changes. Tap **Default** to turn all screens on, and restore them to the factory order and display interval.

2.1.3.1. Import Photos from SD Card

You can import a maximum of nine .JPG images. They must be named DS50Photo#.jpg, where # is from 1 to 9. Copy the images to an SD card, orient the card with the contacts facing up,

gently click the card into the slot, and tap **Import Photos from SD Card**. A status message will ask you to confirm file overwrites, and will report the number of files transferred. These images can be turned on/off and repositioned in the display sequence just like the data display screens.

2.1.4. The Communication Control Screen

This screen lets you password-protect the Communication and Display Control screens, choose your preferred date and time formats, and optionally assign a static IP address to an Ethernet-connected unit. Tap the yellow "wrench" thumbnail to access it (Fig. 8). If a password is in effect, a password screen with soft keyboard will open; tap the password and **OK**.

The upper-left **Host name** is factory-assigned. The **MAC address** is unique to the Ethernet adapter and can be used to trouble-shoot network connection issues. The lower right section of the screen shows the DSPEC 50 software and firmware version numbers, and the serial number for each MCA board in the chassis.

The dynamic or static **IP address** assigned to the Ethernet port is displayed in the upper-right corner. To assign a static IP address, see Appendix A.

To return to the Switchboard without making any changes, tap **Cancel**.

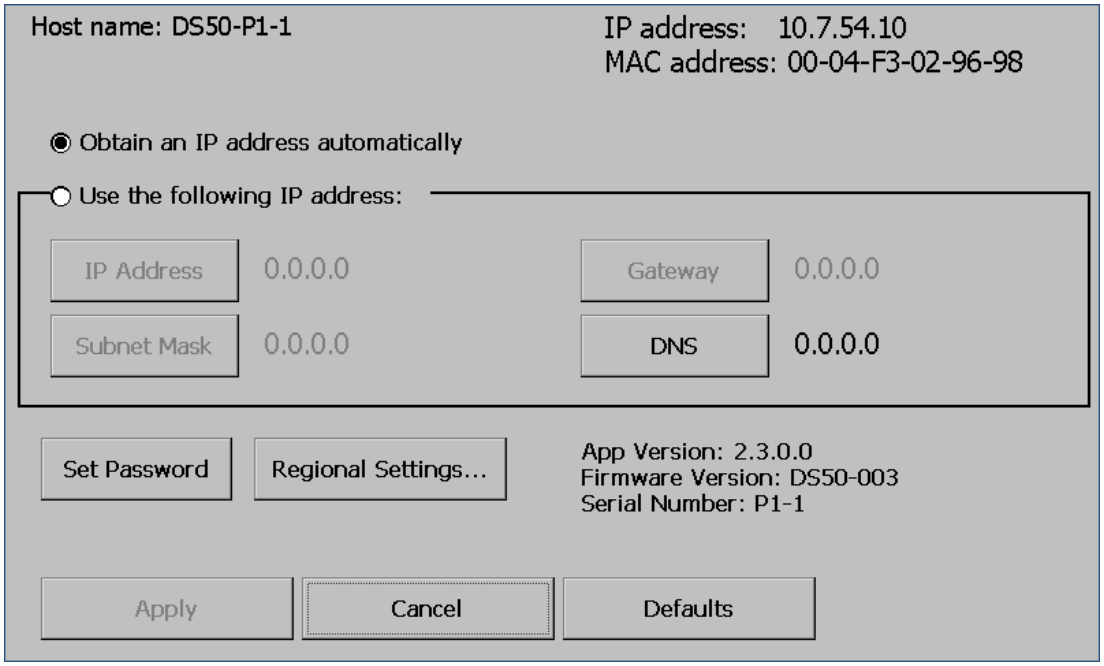


Figure 8. The Communication Control Screen.

2.1.4.1. Set Password

This options lets you set a password to discourage accidental changes to the settings on the Communication Control and Data Display screens. You must re-enter the password each time you attempt to access either screen. Note that you can also block changes to data acquisition settings, spectrum deletion, etc., with the password feature in MAESTRO; see Section 4.7 and the MAESTRO user manual.

To set the password:

- Tap the **Set Password** button to open the soft keyboard shown in Fig. 9. Passwords can be any length, and any combination of uppercase and lowercase letters, and numbers.

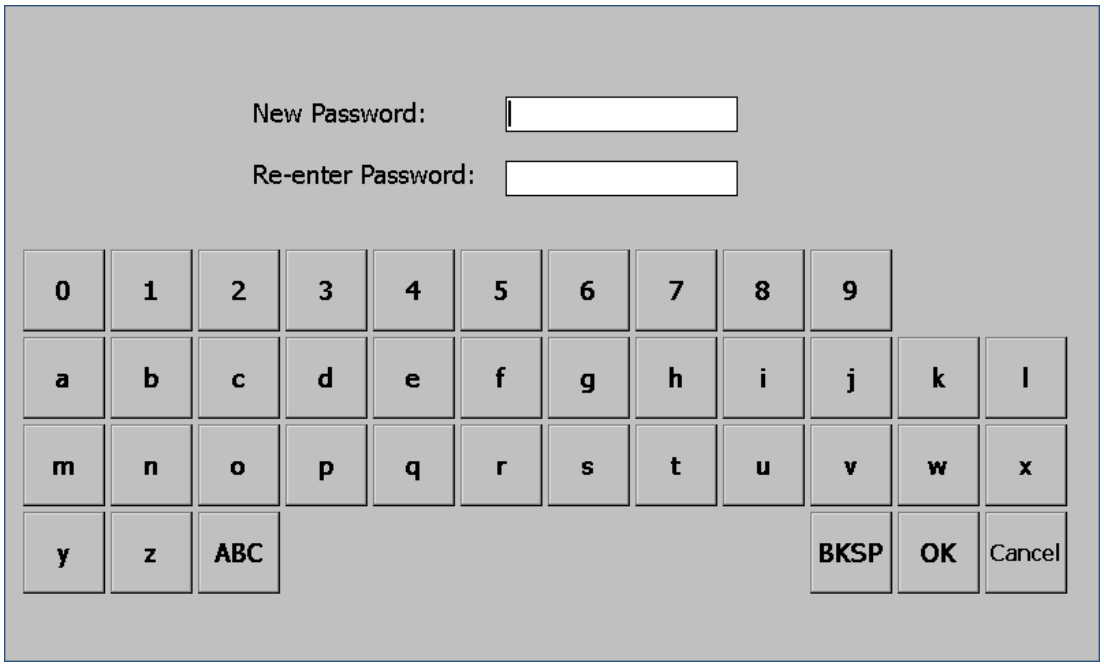


Figure 9. Set or Change Password.

- Enter and reenter the new password. Tap **OK** to accept the new password or **Cancel** to exit the screen with no change. The password goes into effect immediately. When you try to access either of the setup screens, the password screen will be presented first. Enter the password and tap **OK**.

To remove the password:

- Tap **Set Password** to open the password screen, then simply tap **OK**. This will immediately remove the password and return you to Communication Settings screen.

If you forget the password:

- See the reset instructions in Section B.3.

2.1.4.2. Regional Settings...

This accesses the DSPEC 50 computer's Windows Mobile regional settings utility. (You may wish to use a touchscreen stylus to change these settings.) Tap **Regional Settings**, choose the desired locale, and tap **OK**. This will return you to the Communication Control screen. Tap **Apply** to put the new settings into effect and return to the Switch-board.

To modify the settings for the current locale, tap **Customize**. The locale list does not include Far East settings; choose a locale and customize the settings as needed. For additional information, refer to the Microsoft website.

2.1.5. The Data Display Screens

Each MCA in the chassis has four data display screens that track various data acquisition parameters in real time. All four display the following:

- The current time (**Now**); the start time for the current or most recent acquisition (**Started**); and, at the end of acquisition, the stop time of the most recent acquisition (**Finish**).

- A red **HV Off** indicator (HV Off) when the bias is off.

- A bright background when data acquisition is in progress, and a neutral background when acquisition is stopped.

In addition, the two sets of four DSPEC 502 screens are labeled MCA-1 and MCA-2 so you can easily tell which input is currently being displayed.

Use the Display Control screen to display/hide these screens, and set the display order and display interval (Section 2.1.3).

2.1.5.1. The Gauges Screen

This screen gives you a "heads-up" display of **% of preset** remaining, **Dead time %**, and **Input count rate** in cps. Below each gauges is a corresponding text readout (except that no matter the type of preset used, the left-side text readout shows the live time, **LT**).

When no presets are defined, the **% Preset** gauge remains at zero and the **LT** text readout shows the current live-time count.

When counting to a preset, the **% Preset** readout tracks progress, then remains in its final position at the end of acquisition (100% if the preset counted to completion, <100% if the count was manually halted before the preset was reached).

Figures 10 and 11 respectively illustrate the Gauges screen during and after a data acquisition. Note that the **% of preset** gauge in Fig. 10 shows that about 33% of the preset has elapsed. Also, the **Dead time %** gauge and readout, as well as the bright screen background, reflect that a count is in progress. By contrast, in Fig. 11, the 100% reading on the **% of preset** gauge indicates the preset condition has been met; and the neutral background and 0% dead time indicate acquisition has stopped.

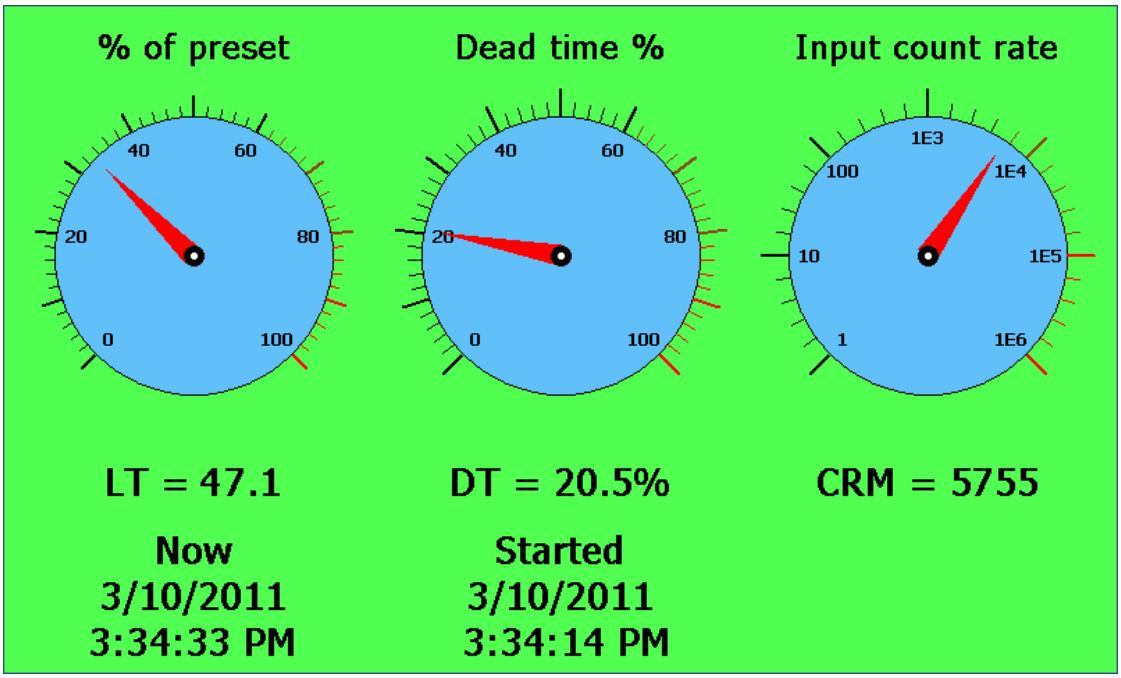


Figure 10. The Gauges Screen During Data Acquisition.

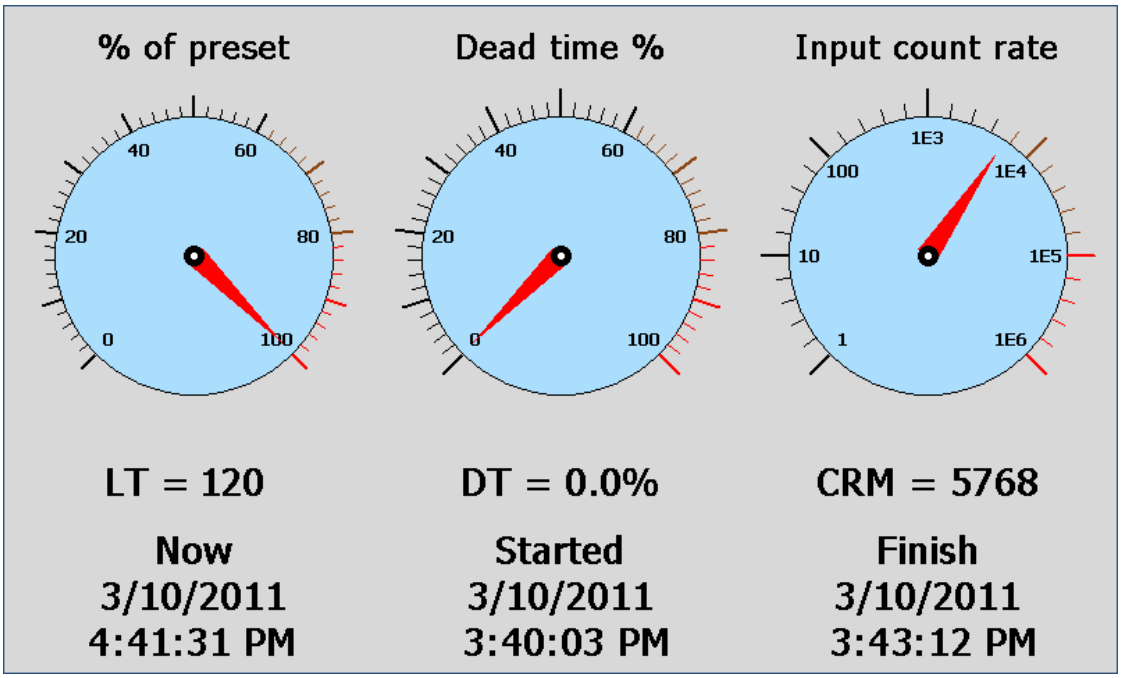


Figure 11. The Gauges Screen, Preset Reached and Acquisition Halted.

2.1.5.2. The Chart Screen

Figure 12 illustrates the Chart screen, which presents "virtual strip-charts" of the current input count rate and % dead time. If the gain and/or zero stabilizers are enabled (Section 4.5), their current % correction is also displayed. In addition; the **Now/Started/Finish** readouts are shown at the bottom of the screen.

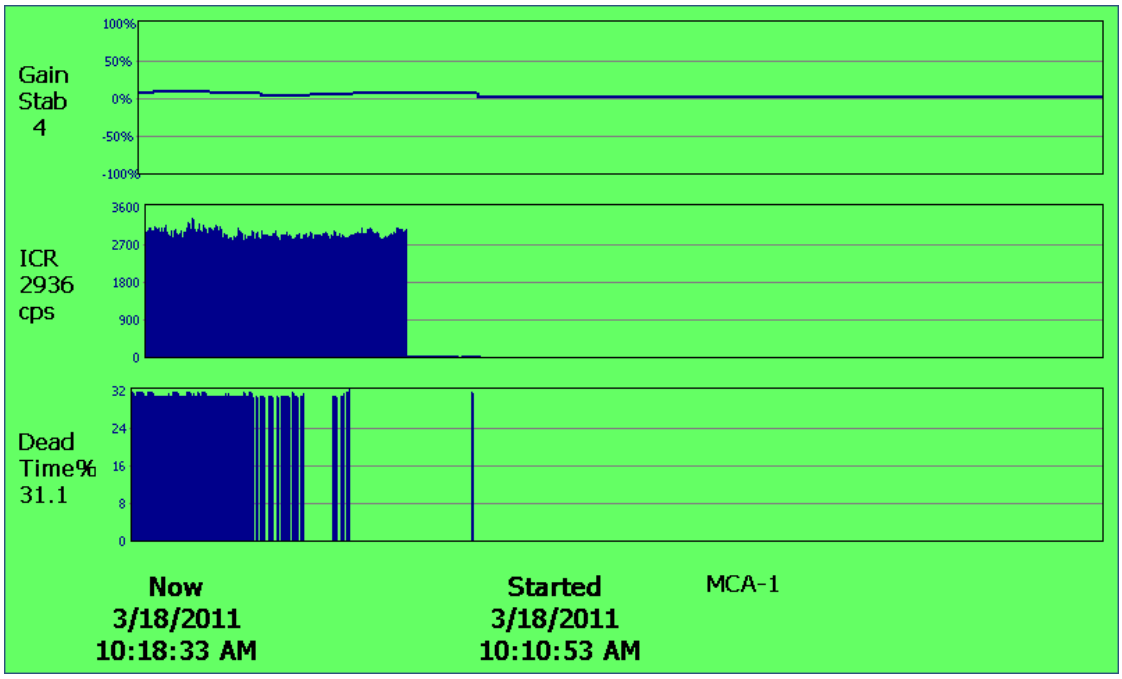


Figure 12. The Chart Screen With Gain Stabilizer Chart.

2.1.5.3. The Spectrum Screen

This screen (Fig. 13) displays the spectrum for the current or most recently acquired spectrum.

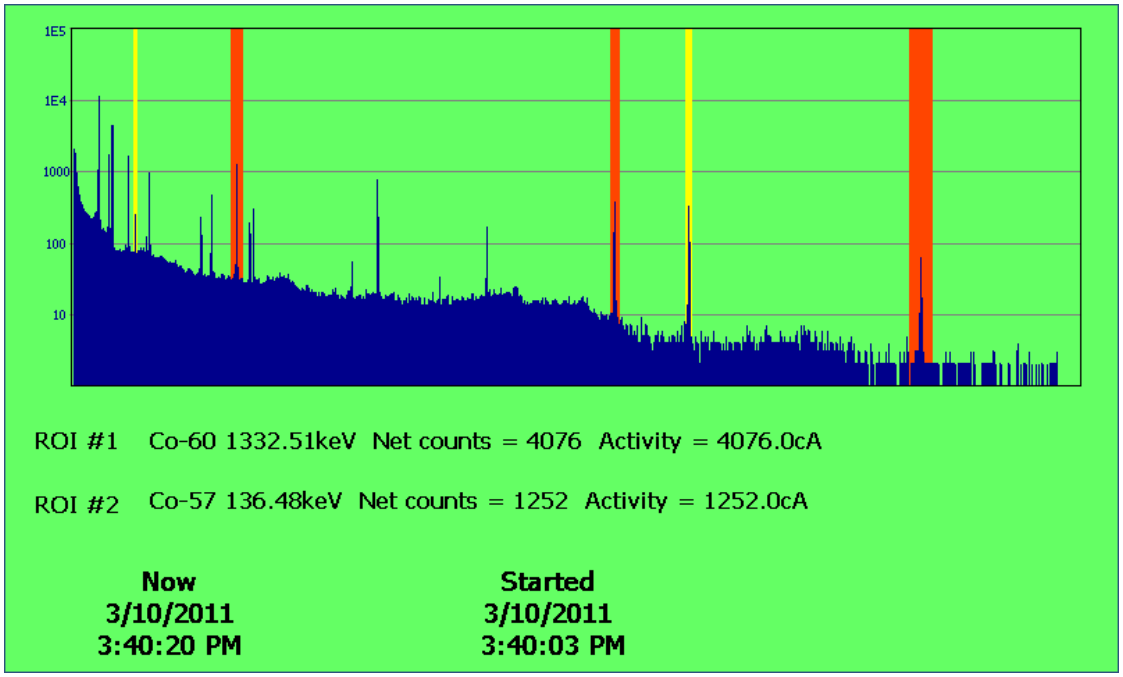


Figure 13. Spectrum Screen (Nuclide Report ROIs are yellow with activity readouts below spectrum; "standard" MAESTRO ROIs are orange with no readouts).

If any Nuclide Report ROIs have been defined (see Section 4.11), the two lowest-energy ROIs are marked with a yellow background, and an activity readout for each is displayed below the histogram. See the two yellow ROIs in Fig. 13. Figure 14 shows the Nuclide Report setup tab for these two ROIs.

If "standard" ROIs have been defined in an ORTEC spectroscopy application, using the commands on the **ROI** menu, they are indicated with an orange background on the DSPEC 50 spectrum screen. See the three orange ROIs in Fig. 13 and refer to the ROI **Mark** command in the software user manual.

For comparison to the Spectrum screen, Fig. 15 shows the corresponding spectrum and "standard" ROIs in GammaVision.

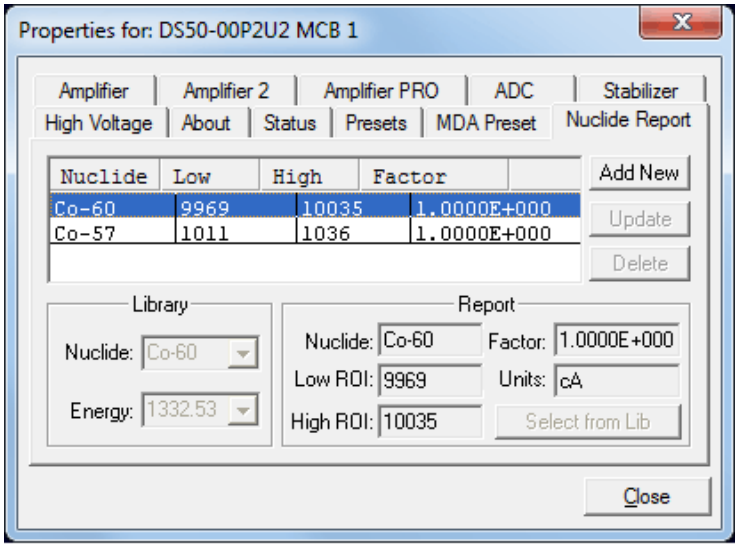


Figure 14. Two Nuclide Report ROIs Defined.

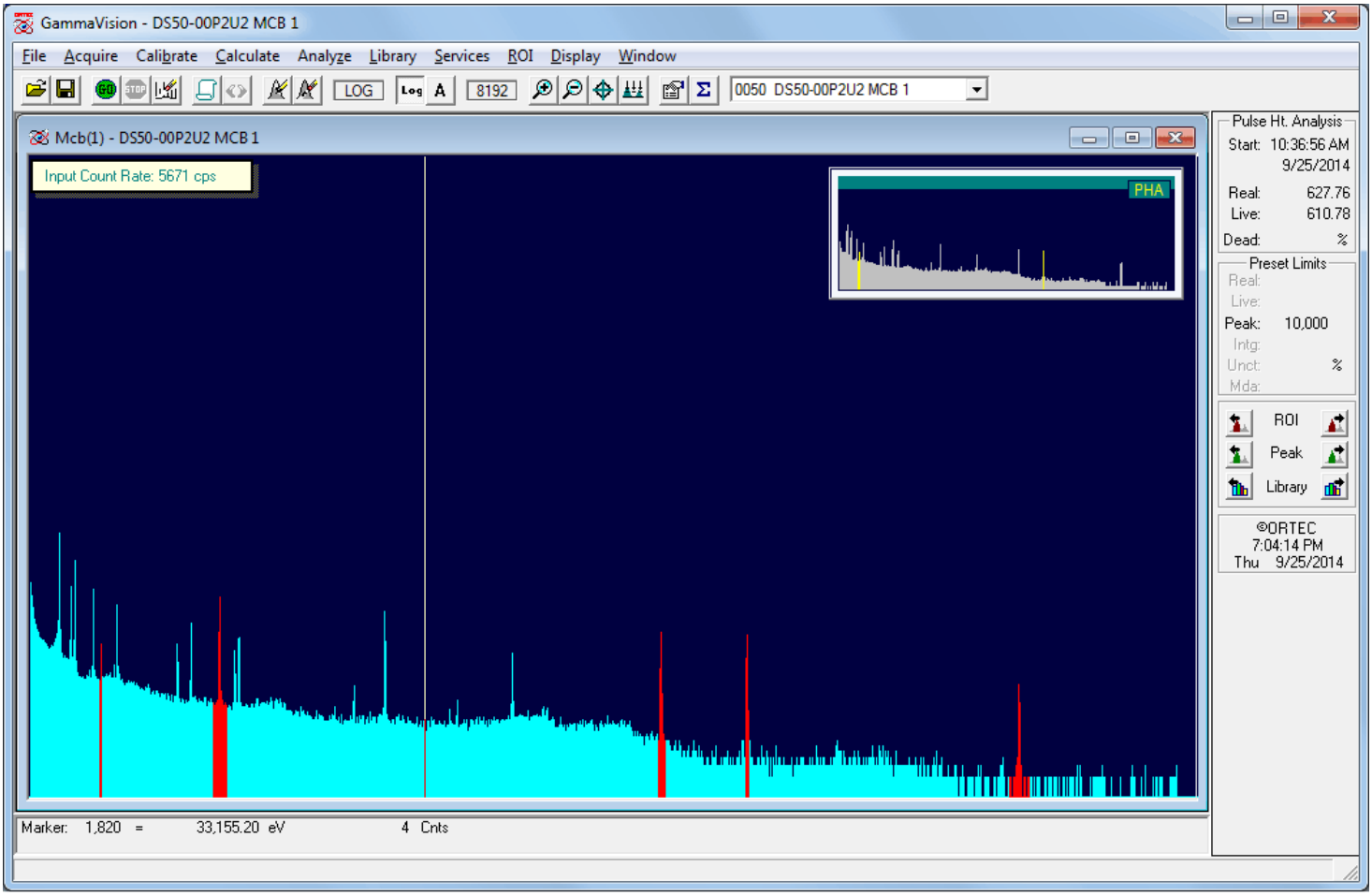


Figure 15. The Spectrum in GammaVision (showing "standard" ROIs).

2.1.5.4. The Big Numbers Screen

The Big Numbers screen makes the current data acquisition status highly visible, even from across the counting lab. Note the **HV Off** indicator on the bottom right of Fig. 16.

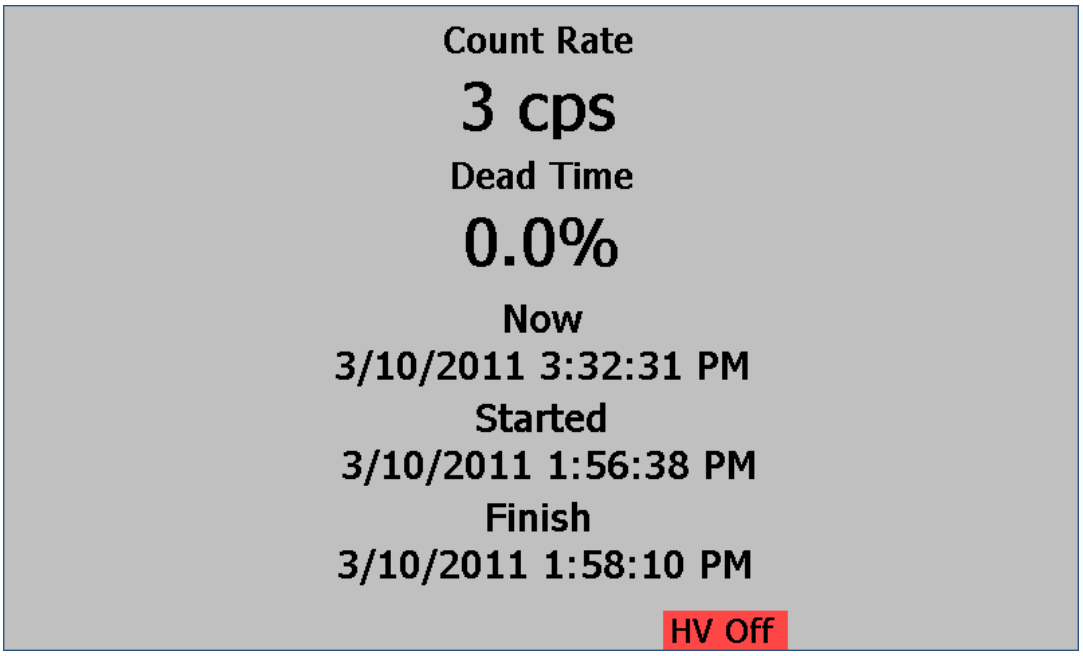


Figure 16. The High-Visibility "Big Numbers" Screen, Showing the HV Off Indicator.

2.2. Rear Panel

Figures 17 and 18 respectively show the rear panels of the DSPEC 50 and DSPEC 502. Note that each chassis has only one ac input power module, Ethernet connector, USB connector, SD card slot, and RESET port. Otherwise, each MCA has the following set of inputs and outputs. On the DSPEC 502, some connector labels are abbreviated due to space constraints; the abbreviations are given in parentheses below. See Section 5.1.1 for more detail on the inputs and outputs.

DIM Multi-pin (13W3) connector supports the SMART-1 and other ORTEC DIM detectors. No other rear-panel detector connections are required.

CAUTION

To avoid damaging the detector interface module (DIM) cable, be sure to observe the following: (1) When attaching a detector to the DIM connector, always tighten the cable's retaining screws to the rear panel. (2) Before disconnecting the detector from the DIM connector, always power off the DSPEC-50.

INPUT Rear-panel BNC accepts preamplifier output signals of either polarity.

PREAMP POWER Rear-panel, 9-pin D connector; provides ±24 V and ±12 V for preamplifier power.

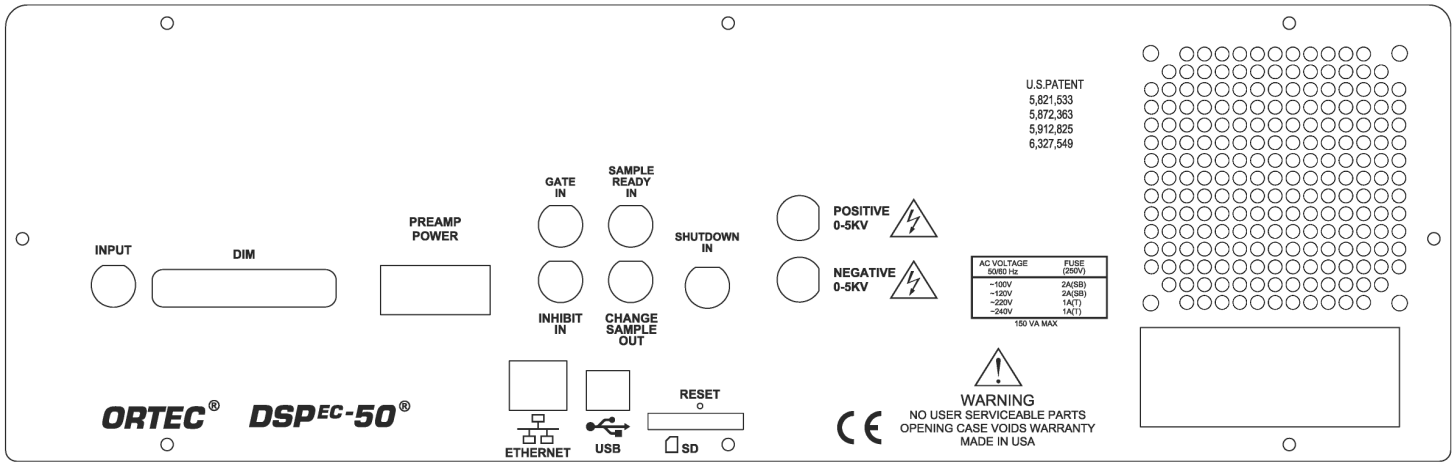


Figure 17. The DSPEC 50 Rear Panel.

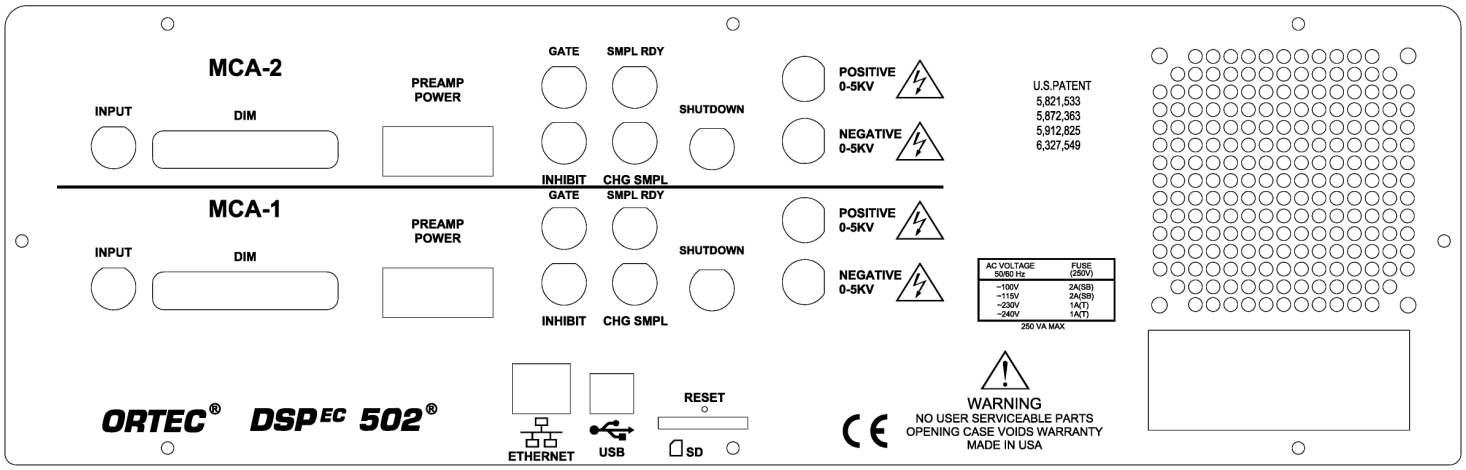


Figure 18. The DSPEC 502 Rear Panel.

GATE IN (GATE) (Not available for -PLUS [transistor-reset preamplifier] or SMART-1 detectors.) Accepts a positive TTL input via the DIM's "Inhibit" BNC. Signal must occur prior to and extend 0.5 μs beyond peak detect. Software-selectable as off, coincidence, or anticoincidence.

INHIBIT IN (INHIBIT) Rear-panel BNC connector accepts reset signals from TRP or POF preamplifiers.

SHUTDOWN IN (SHUTDOWN) Rear-panel BNC turns off the bias supply voltage when the detector is warm. Software-selectable ORTEC or TTL mode (SMART-1 detectors auto-select the SMART shutdown mode). In ORTEC mode, the detector's Bias Shutdown cable must be connected to this input or the high voltage will not turn on.

CHANGE SAMPLE OUT (CHG SMPL) Rear-panel BNC connector, TTL compatible.

SAMPLE READY IN (SMPL RDY) Rear-panel BNC connector accepts TTL level signal from sample changer.

HIGH VOLTAGE

- **Positive 0–5 kV** Rear-panel SHV connector, 500 V–5 kV. Only active when the unit is set for positive bias.
- **Negative 0–5 kV** Rear-panel SHV connector, 500 V–5 kV. Only active when the unit is set for negative bias.

ETHERNET Standard 10/100 Mbit Ethernet connection. Link and Activity LEDs are integrated into the connector.

USB Emulates a USB connection. Any number of DSPEC 50s can be connected to a host computer via USB.

SD SecureDigital™ (SD) memory card slot for uploading a maximum of 9 optional .JPG-format image files. See page 19.

RESET Maintenance port.

AC (MAINS) POWER MODULE 100–240 V ac, 47–63 Hz, 110 watts. The unit is shipped with the voltage setting, fusing, and 3-prong grounded ac power cord appropriate for your location. To change the fuses or voltage setting, see the next section.

2.2.1. Changing the Fuse(s) and Line Voltage

This instrument uses a power entry module that includes a reversible fuse holder and a voltage selector card. The voltage selector card lets you configure the instrument for a nominal 100, 120, 230, or 240 V ac. The module door has a small window that shows the line voltage setting now in use.

To open the module:

1) Be sure the instrument is disconnected from the ac (mains) power source.

2) Insert a small flat-blade screwdriver in the small gap under the left side of the module's door, as shown in Fig. 19.

3) Gently lift up until the entire door pops up approximately 0.25 inch (Fig. 20).

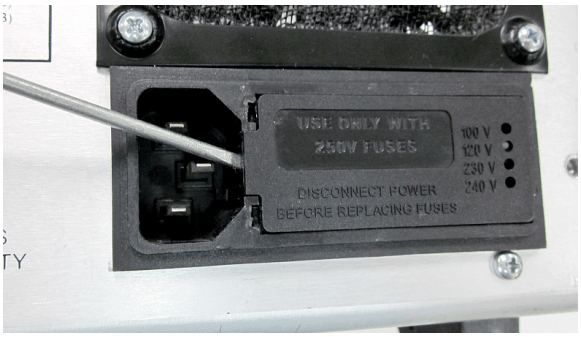


Figure 19. Insert Screwdriver in Gap Under Door.

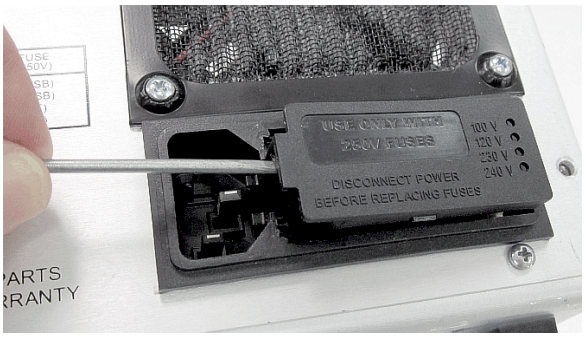


Figure 20. Lift the Door.

4) The door can now be opened from the right, exposing the fuse holder and voltage selector card (Fig. 21).

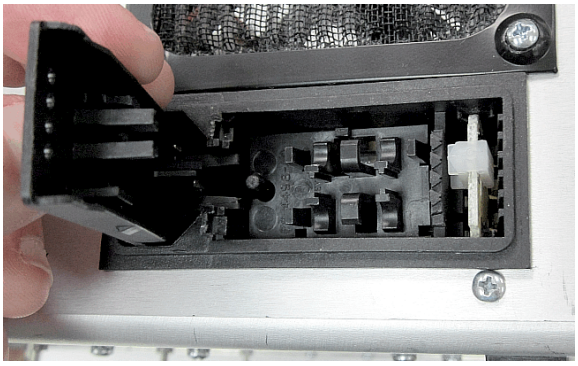


Figure 21.

2.2.1.1. Replacing the Fuse(s)

1) With the unit disconnected from ac power, lift out the reversible fuse holder (Fig. 22).

2) This instrument requires the following 250 V fuses:

- For 100 or 120 V ac line voltage, one fuse, 2 A (SB) size 3AG.
- For 230 or 240 V ac line voltage, two fuses, 1 A(T) size 5×20 mm.

CAUTION Do not use makeshift fuses or short-circuit the fuse holders, and do not install both AG and metric fuses at the same time.

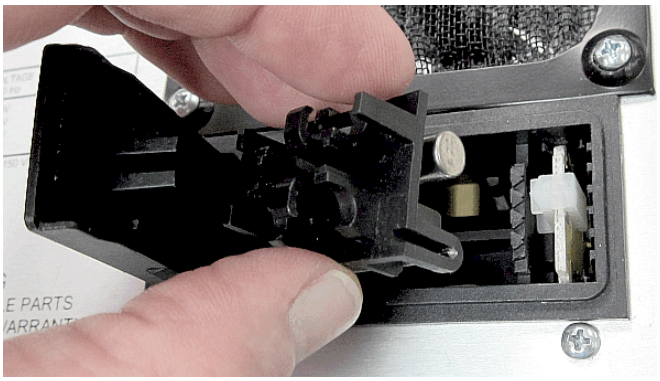


Figure 22. Remove the Fuse Holder.

Figure 23 shows the 100 V/120 V side with an AG fuse in place. In Fig. 24, the fuse holder has been rotated to show the 230 V/240 V side (facing right) and the two brackets for its metric fuses.

Figure 23. Fuse Holder — AG Side.

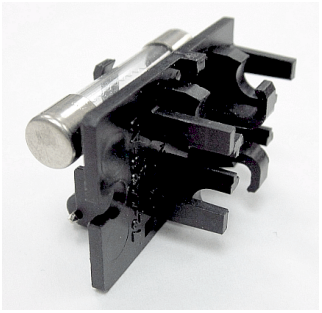


Figure 24. Fuse Holder — Metric Side.

3) Change the fuse(s), then reinsert the fuse holder *fuse side down* (thus, for 100 or 120 V ac line voltage, the single AG fuse should face down; and for 230 or 240 V ac line voltage, the twin metric fuses should face down). Gently press down until the fuse holder is fully seated. Close the module door as described in Section 2.2.1.3.

2.2.1.2. Changing the Line Voltage

1) Use the indicator pin to pull the voltage selector card straight out of the module. If necessary, lift the indicator pin a few millimeters, slide the shaft of a small flat-blade screwdriver under the top of the pin, and use the screwdriver to *gently* lift out the card, as shown in Fig. 25.

2) Unclip the white plastic indicator pin from the card.

3) Orient the card so the desired voltage is readable at the bottom. Figure 26 shows the orientations for the four voltage settings and how to replace the indicator pin in the card for that voltage. Note that the arrow beside the setting indicates the edge of the card you will insert first into the power entry module.

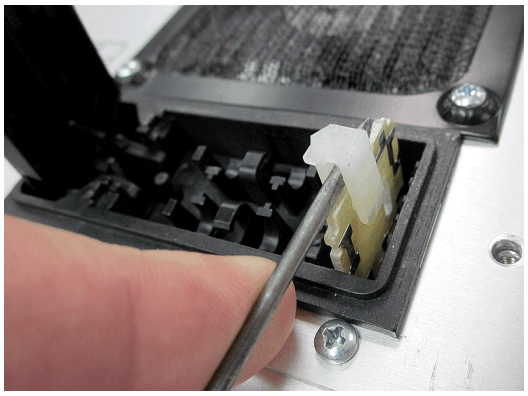


Figure 25. Gently Pull Out Voltage Selector Card.

4) Reinsert the card into the module, *printed side of the card facing left, toward the IEC power connector, with the edge listing the desired voltage first (down).* Gently but firmly press the card into the module until it is fully seated.

5) Close the module door as described in Section 2.2.1.3.

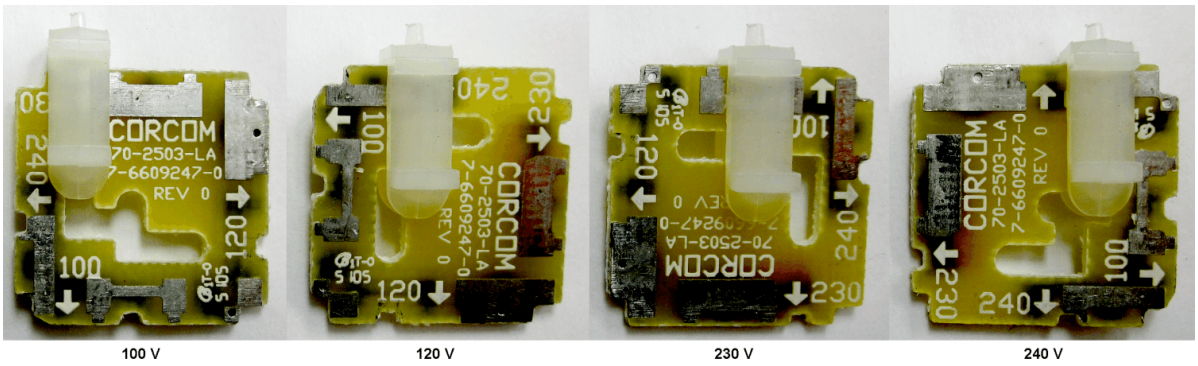


Figure 26. Orient the Voltage Selector Card and Clip On the Indicator Pin.

2.2.1.3. Closing the Input Power Module

1) When you have completed changes to the line voltage and/or fusing, close the module door, then gently press it down until it is fully seated and firmly holding the fuse holder and voltage selector card in place.

2) Verify that the white indicator pin shows the desired voltage. Figure 27 shows the instrument set for 120 V.

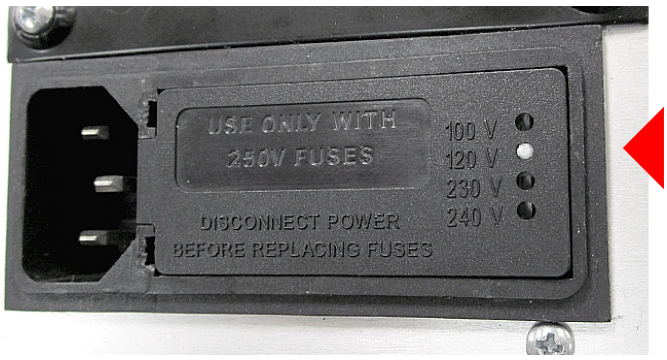


Figure 27. Note Position of Voltage Indicator Pin.

3) You are now ready to connect the unit to the ac power source using the appropriate power cord (mains lead).

3. HARDWARE AND SOFTWARE INSTALLATION

Installing the DSPEC 50 takes just five straightforward steps:

1) Confirm the line (mains) voltage, fusing, and input power cord are correct for your region.
2) Install the included CONNECTIONS Driver Update Kit, v7.02.03 or higher (p/n 797230).
3) Install the included MAESTRO MCA Emulation Software (A65-BW) or your ORTEC spectroscopy software application.
4) Connect the DSPEC 50 to your network or computer.
5) Run the MCB Configuration program to establish communication with your MCBs.

NOTE You must have Windows administrator-level access to install ORTEC software.

3.1. Step 1: Line Voltage, Fusing, and Power Cord

ORTEC factory-sets the DSPEC 50 line voltage, fusing, and input power cord based on your location. However, before you use the unit, we strongly recommend that you confirm it is properly set up for your region's ac mains supply. For instructions on changing the line voltage and fusing, see Section 2.2.1.

3.2. Step 2: Install the CONNECTIONS Driver Update

Next, install the accompanying CONNECTIONS Driver Update Kit (P/N 797230) according to its instruction sheet. This product must be installed before your spectroscopy application is installed. On the Instrument Families page, be sure to mark the **USB-based** instruments checkbox. ***Otherwise, USB-connected DSPEC 50s will not be able to communicate with the computer and ORTEC software.*** No instrument family selection is required if you will only be communicating via Ethernet.[12]

If you also have other types of MCBs attached to this computer, refer to the installation instructions in the corresponding hardware manuals. Note that you can install device drivers for other types of instruments later,-as described in the CONNECTIONS Driver Update Kit instructions.

[12]If you also have non-Ethernet MCBs, each will require setup according to its hardware manual, including selection of the proper Instrument Family in the CONNECTIONS Driver Update wizard. You can enable other device drivers later, as described in the Update Kit instructions.

3.3. Step 3: Install the Spectroscopy Application Software

Install MAESTRO or another ORTEC spectroscopy application according to the instructions in its user manual.

3.4. Step 4: Connect the DSPEC 50 to Your Network or Computer

NOTE *You can attach DSPEC 50s directly to your computer **either** by Ethernet **or** by USB connection, but do not mix the two connection types on the same computer or operational errors could occur. If you switch a DSPEC 50 from one connection type to the other, you must re-run the MCB Configuration program to reestablish communication between the DSPEC 50 and the computer.*

3.4.1. Ethernet Connection

- **Case 1: LAN With DHCP Server — Dynamic IP Addressing**
  Most users will connect one or more DSPEC 50s, via the rear-panel **Ethernet** port, to a standard LAN. This is the simplest connection method: Just attach the DSPEC 50 to your network with a standard Cat 5 (RJ45) Ethernet cable, power the DSPEC 50 on, wait 10–15 seconds for the network's DHCP server to assign a dynamic IP address to the DSPEC 50, and you're ready to run the MCB Configuration program (Section 3.5). *In addition to these networked DSPEC 50s, you can attach DSPEC 50s directly to your computer **either** by Ethernet **or** by USB connection,* as described in the next two paragraphs and Section 3.4.2.

- **Case 2: LAN Without DHCP Server or Standalone Laptop/Computer With LAN Adapter — Dynamic IP Addressing**
  If you (a) connect multiple DSPEC 50s to a network that does not have a DHCP server, or (b) have an isolated computer with a LAN adapter, and wish to attach multiple DSPEC 50s to the computer via a powered Ethernet switch, Windows will auto-assign IP addresses to each DSPEC 50. To do this, attach the DSPEC 50s to your network (or to the standalone computer's Ethernet switch) with a standard Ethernet cable, power the DSPEC 50s on, wait 3–5 minutes for the IP addresses to be assigned, and you're ready to run the MCB Configuration program (Section 3.5).

- **Case 3: Static IP Addressing**
  (a) If for any reason the network DHCP server or the host computer does not auto-assign an IP address to your DSPEC 50, or (b) if you are otherwise using static IP addressing, see the instructions in Appendix A. When all units have been assigned a static IP address, you're ready to run the MCB Configuration program (Section 3.5).

3.4.2. USB Connection

With the computer powered on, connect the DSPEC 50 to a USB port on the computer, power the DSPEC 50 on, and wait for it to initialize and display the Switchboard screen.

Windows will indicate that the DSPEC 50 has been detected. In Windows 8 and 7, the driver will install without a wizard. In XP, the new hardware installation wizard will open. Click **Next**, indicate you *do not* wish to connect to the internet or the Microsoft website to locate the driver, choose the "automatically locate driver" option, and follow the remaining prompts to completion. When this operation is complete, you're ready to run the MCB Configuration program (Section 3.5).

3.5. Step 5: Run MCB Configuration to Establish Communication With Your MCBs

IMPORTANT

This is an abbreviated discussion of the operation and use of the MCB Configuration program. We *strongly* recommend that you read the instructions for the CONNECTIONS Driver Update Kit for complete details on the command line arguments that change how the program searches for MCBs, customizing MCB ID Numbers and Descriptions, changing your Windows firewall settings to allow MCB access across a network, enabling additional device drivers, and troubleshooting.

1) Make sure the DSPEC 50 is connected and powered on.

2) Connect and power on all other local and network ORTEC instruments that you wish to use, as well as their associated computers. Otherwise, the MCB Configuration program will not detect them during installation. Any instruments not detected can be configured another time.

3. Type mcb in the "*Search programs and files*" box on the Windows Start menu, then click the **MCB Configuration** search result; or open the Windows Start menu and click **MAESTRO**, then **MCB Configuration**. *For Ethernet-connected DSPEC 50s, do not append the -L switch to the command line (the -L switch can only locate local, USB-connected DSPEC 50s).*

   The MCB Configuration program will locate all of the powered-on ORTEC MCBs on the local computer and the network, and display the *Master Instrument List* of instruments found (Fig. 28). Each DSPEC 50 will be identified in the list by the **Host name** displayed on the Communication Control screen (Fig. 8, page 20). If you have a DSPEC 502, both inputs will be discovered, and will be assigned the host name appended with MCB 1 and MCB 2.

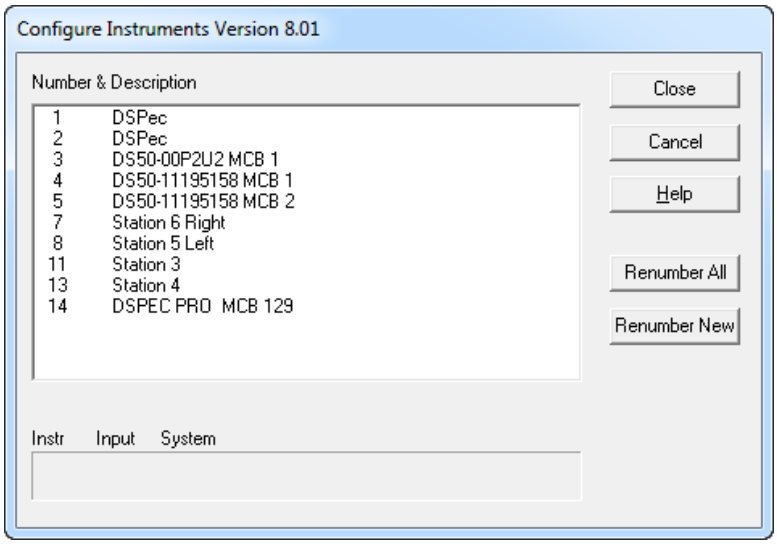


Figure 28. MCB Numbering and Descriptions.

3.5.1. Configuring a New Instrument

The first time a new instrument is detected, the dialog shown in Fig. 29 will remind you that all new instruments must be assigned a unique, *non-zero* ID number.[13] Click **OK**. You can either manually change the ID Number and Description as described in the next subsection, or you can click the **Renumber New** button to renumber only the new instruments.

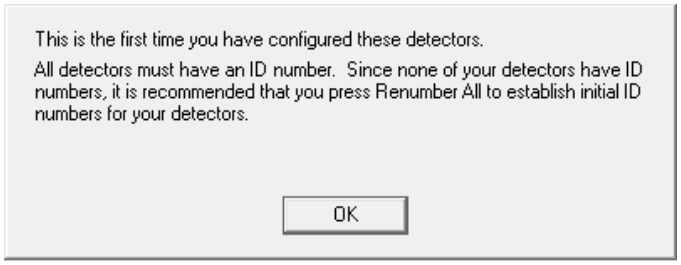

This is the first time you have configured these detectors.
All detectors must have an ID number. Since none of your detectors have ID numbers, it is recommended that you press Renumber All to establish initial ID numbers for your detectors.
OK

Figure 29. New Instruments Must Have a Non-Zero ID Number.

NOTE ***We strongly recommend not using the* Renumber All *button.*** In addition, we strongly recommend ***not*** renumbering MCBs that "belong" to other users, as this could affect the interaction between their MCBs and their ORTEC software, for instance, if they control their MCBs with .JOB files (e.g., the .JOB file command SET_DETECTOR 5), or use the GammaVision or ISOTOPIC spectroscopy applications. See also the NOTE FOR MULTIPLE USERS ON A NETWORK in the next section.

3.5.2. Customizing ID Numbers and Descriptions

If you wish, you can change the instrument ID Numbers and Descriptions by double-clicking an instrument entry in the Configure Instruments dialog. This will open the Change Description or ID dialog (Fig. 30). It shows the physical MCB location (read-only), and allows you to change the **ID** Number and **Description**.

[13] If this is a first-time installation of ORTEC products, all your instruments will be "new."

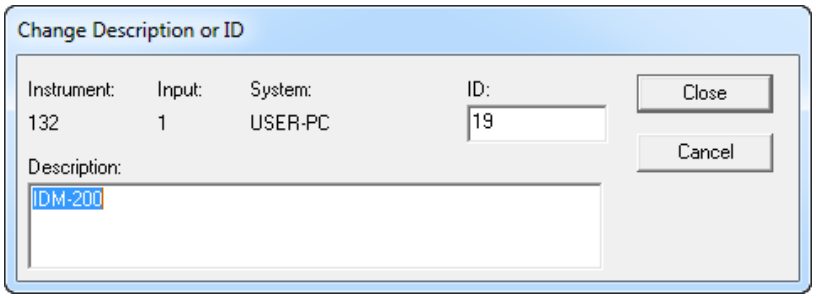


Figure 30. Change MCB Number or Description.

Make the desired changes and click **Close**. Any changes you have made to an ID number or description will then be written back to the corresponding MCB.

NOTE FOR MULTIPLE USERS ON A NETWORK

There are two ways to reduce the chance that other users will renumber your MCBs:

- Add the `-I` flag to their MCB Configuration command line, as described in the CONNECTIONS Driver Update Kit instructions. This will allow you to assign whatever ID Numbers you wish, regardless of the numbers assigned by other users on your network. (Ideally, everyone using ORTEC instruments on your network should make this change.)

- To prevent others from renumbering your MCBs (or performing any other actions except read-only viewing), password-lock your MCBs with the MAESTRO **Lock/Unlock Detector** command. If you lock a detector that will be controlled by a JOB stream, remember to include the proper password-unlock commands in your `.JOB` file (see the MAESTRO user manual).

If a modified description has already been applied to a particular instrument, you can restore the default description by deleting the entry in the **Description** field and re-running MCB Configuration. After MCB Configuration runs, the default description will be displayed.

3.5.3. Connecting to and Disconnecting from the Computer

The DSPEC 50 can be connected to and disconnected from the computer without shutting down either. If you disconnect from the computer during data acquisition (leaving the DSPEC 50 under power so that the high voltage stays on), the DSPEC 50 will continue data collection. To redisplay the spectrum, simply reconnect the DSPEC 50 via the same method (Ethernet or USB), then close and reopen the MAESTRO spectrum window for that input.

[Intentionally blank]

4. MCB PROPERTIES IN MAESTRO

This chapter discusses the hardware setup dialog you will see within MAESTRO and all other ORTEC CONNECTIONS software (e.g., GammaVision, ISOTOPIC) when you click **Acquire/ MCB Properties...**. Data acquisition with the DSPEC 50 is completely software controlled. The MCB Properties dialog contains all of the instrument controls including ADC setup parameters, acquisition presets, amplifier gain adjustments, pole-zero controls, detector bias controls, and access to the InSight Virtual Oscilloscope. Just move from tab to tab and set your hardware parameters, then click **Close**.

Note that as you enter characters in the data-entry fields, the characters will be underlined until you move to another field or until 5 seconds have elapsed without further input. While the entry is underlined, no other program or computer on the network can modify this value.

4.1. Amplifier

Figure 31 shows the Amplifier tab. This tab contains the controls for **Gain**, **Baseline Restore**, **Preamplifier Type**, **Input Polarity**, and **Optimize**.

NOTE Be sure that all of the controls on the tabs have been set *before* clicking the **Start Auto** (optimize) button. The changes you make on most property tabs *take place immediately*. There is no cancel or undo for these dialogs.

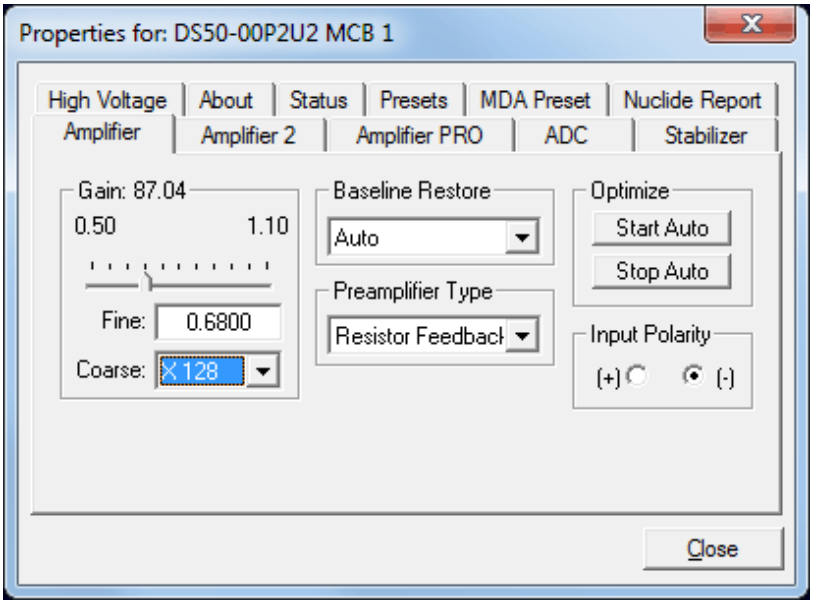


Figure 31. DSPEC 50 Amplifier Tab.

Gain — Set the amplifier coarse gain by selecting from the **Coarse** droplist, then adjust the **Fine** gain with the horizontal slider bar or the edit box, in the range of 0.5 to 1.1. The resulting effective gain is shown at the top of the **Gain** section. The two controls used together cover the entire range of amplification from 0.5 to 140.8.

Input Polarity — These buttons select the preamplifier input signal polarity for the signal from the detector. Normally, GEM (p-type) detectors have a positive signal and GMX (n-type) have a negative signal.

Baseline Restore — This is used to return the baseline of the pulses to the true zero between incoming pulses. This improves the resolution by removing low frequency noise from dc shifts or mains power ac pickup. The baseline settings control the time constant of the circuit that returns the baseline to zero. There are three fixed choices (**Auto**,[7] **Fast**, and **Slow**). The fast setting is used for high count rates, the slow for low count rates. **Auto** adjusts the time constant as appropriate for the input count rate. The settings (**Auto**, **Fast**, or **Slow**) are saved in the DSPEC 50 even when the power is off. The time constant can be manually set on the InSight display (see the discussion beginning on page 42).

You can view the time when the baseline restorer is active on the InSight display as a **Mark** region (see the discussion on Marks, p. 44). In the automatic mode, the current value is shown on the InSight sidebar (Fig. 33). For a low-count-rate system, the value will remain at about 90.

Preamplifier Type — Choose **Transistor Reset** or **Resistive Feedback** preamplifier operation. Your choice will depend on the preamplifier supplied with the germanium detector being used.

4.1.1. Optimize

The DSPEC 50 is equipped with both automatic pole-zero logic[6] and automatic flattop logic.[14] The **Start Auto** (optimize) button uses these features to automatically choose the best pole-zero and flattop tilt settings. Note that if you selected **Transistor Reset** as the **Preamplifier Type** for this DSPEC 50, optimization does not perform the pole zero.

NOTE You cannot optimize with LFR mode enabled; see Section 4.3.

As with any system, the DSPEC 50 should be optimized any time the detector is replaced or if the flattop width is changed. For optimization to take place, the DSPEC 50 must be processing pulses. The detector should be connected in its final configuration before optimizing. A count rate guidance message on the lower-left of the Amplifier page will help you position a radio active source to deliver the correct count rate for optimization. The **Start Auto** optimization button will be disabled (gray) until the count rate is suitable.

Select either the **Resistive Feedback** or **Transistor Reset** option and click **Start Auto**. The optimize command is sent to the DSPEC 50 at this time and, if the DSPEC 50 is able to start the operation, a series of short beeps sounds to indicate that optimization is in progress. When optimizing is complete, the beeping stops.

During optimization, pole zeroes are performed for several rise-time values and the DSPEC 50 is cycled through all the rise time values for the determination of the optimum tilt values. All

[14]Patent number 5,821,533.

values for all the combinations are then saved in the DSPEC 50, so you do not need to optimize for each possible rise time. Optimization can take from 1 to 10 minutes depending on count rate, but typically takes 5 minutes.

NOTE Be sure to repeat the optimization if you change the flattop width.

The effect of optimization on the pulse can be seen in the InSight mode, on the Amplifier 2 tab. Note, however, that if the settings were close to proper adjustment before starting optimization, the pulse shape may not change enough for you to see. (In this situation, you also may not notice a change in the shape of the spectrum peaks.) The most visible effect of incorrect settings is high- or low-side peak tailing or poor resolution.

4.2. Amplifier 2

Figure 32 shows the Amplifier 2 tab, which accesses the advanced shaping controls including the InSight Virtual Oscilloscope mode.

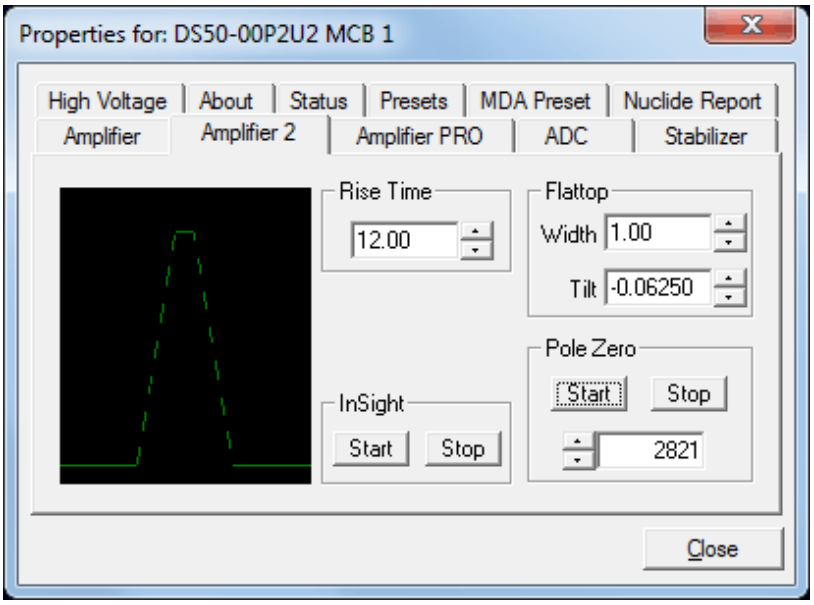


Figure 32. DSPEC 50 Amplifier 2 Tab.

The many choices of **Rise Time** allow you to precisely control the tradeoff between resolution and throughput; see Section 4.12. This setting affects both the rise and fall times, so changing it spreads or narrows the quasi-trapezoid symmetrically.

Use the up/down arrows to set the **Rise Time** from 0.8 µs to 23.0 µs. Once the unit has been optimized according to Section 4.1.1, you can use any **Rise Time** without having to re-optimize.

The value of the rise time parameter in the DSPEC 50 is roughly equivalent to twice the integration time set on a conventional analog spectroscopy amp-lifier. Thus, a DSPEC 50 value of 12 µs corresponds to 6 µs in a conventional amplifier. Starting with the nominal value of 12.0, you should increase values of the rise time for better resolution for expected lower count rates, or when unusually high count rates are anticipated, reduce the rise time for higher throughput with somewhat worse resolution.

The **Flattop** controls adjust the top of the quasi-trapezoid. The **Width** adjusts the extent of the flattop (from 0.3 to 2.4 μs). The **Tilt** adjustment varies the "flatness" of this section slightly. The **Tilt** can be positive or negative. Choosing a positive value results in a flattop that slopes downward; choosing a negative value gives an upward slope. Alternatively, the optimize feature on the Amplifier tab can set the tilt value automatically. This automatic value is normally the best for resolution, but it can be changed on this dialog and in the InSight mode to accommodate particular throughput/resolution tradeoffs. The optimize feature also automatically adjusts the pole-zero setting.

The dead time per pulse is approximately $(3 \times \textit{Rise Time}) + (2 \times \textit{Flattop Width})$.

In the **Pole Zero** section, the **Start** button performs a pole zero at the specified rise time and other shaping values. Unlike the optimize feature, it performs a pole zero for only the one rise time. The pole-zero **Stop** button aborts the pole zero, and is normally not used.

For the more advanced user, the InSight mode allows you to directly view all the parameters and adjust them interactively while collecting live data. To access InSight mode, click the **Start** button. The InSight mode is discussed in more detail in the following section. Once data acquisition is underway, you may wish to start the Insight mode to adjust the shaping parameters interactively with a "live" waveform showing the actual pulse shape, or just to verify that all is well.

4.2.1. InSight Mode

The **InSight** display (Fig. 33) shows the actual sampled waveform in the digital processing units on a reference graticule. The Properties dialog remains active and can be used to change settings while viewing the pulses.

As none of the traditional analog signals are available in the DSPEC 50, this mode is the only way to display the equivalent amplifier output pulse. Note that at the bottom of the window the marker channel is displayed in units of time.

To exit the InSight mode and return to the PHA display, press **<Esc>** or go to the **Insight** section on the Amplifier 2 tab and click **Stop**. The PHA mode is set to STOP when you enter the InSight mode.

The Status Sidebar changes from the PHA mode controls to the InSight controls for adjusting the peak display (Fig. 33). On the left is a vertical scrollbar for adjusting the vertical offset of the waveform. The value of the offset is shown on the display. Double-clicking the mouse in the scrollbar will set the vertical offset to the vertical value of the channel at the marker position. This lets you conveniently zoom in on a particular part of the waveform (such as the tail for pole-zeroing).

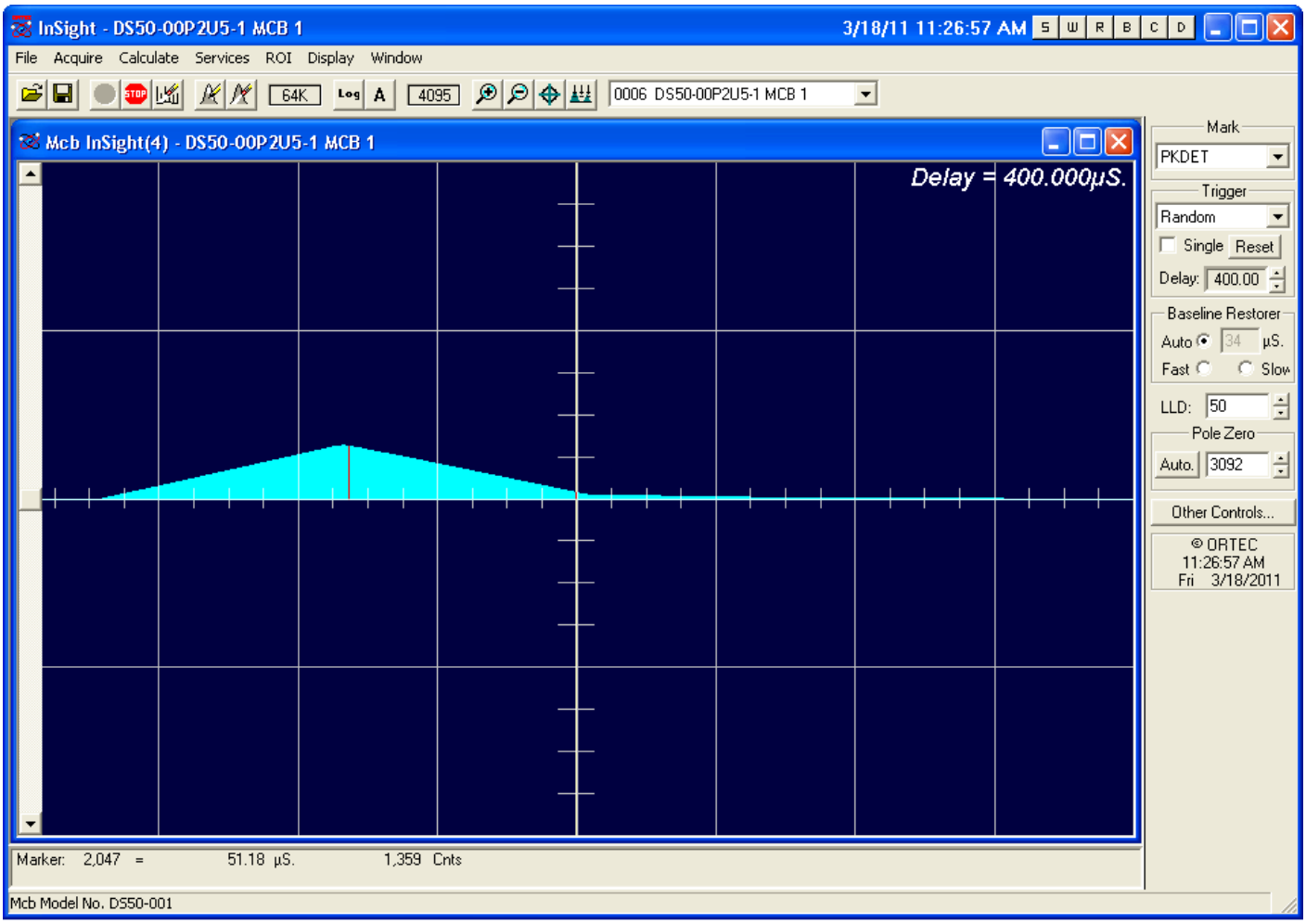


Figure 33. DSPEC 50 InSight Mode.

In the **Auto** trigger mode, the display is updated every time a new pulse exceeds the trigger level. To keep a single pulse displayed, select **Single**. Click **Reset** to refresh the display to see the next pulse. There will usually be one or two pulses in the “pipeline” that will be displayed before any change entered will be seen. If the trigger is turned off, the display will be redrawn periodically, even if no pulse is there.

The **Delay** setting is the time delay between the pulse shown on the display and the trigger level crossing. The value of the time delay is shown on the display.

Just as for the PHA mode display, the vertical scale can be adjusted with the vertical adjustments. The display can be set to Log mode, but the peak shapes do not have a familiar shape in this display. The Auto mode will adjust the vertical scale for each pulse. The pulse is shown before the amplifier gain has been applied, so the relation between channel number and pulse height is not fixed.

The horizontal scale extends from 16 to 4095 channels. The display is expanded around the marker position which means that in some cases the peak will disappear from the display when it is expanded.

The display can be switched from the DSPEC 50 to another detector or the buffer. In this case the other detector will be shown in the mode selected for it. The buffer will always be shown in PHA mode. The display will return to the InSight mode when you return to the first DSPEC 50. If you exit the program with the DSPEC 50 in InSight mode, it will be in InSight mode on the next startup.

The display can include a **Mark** to indicate one of the other signals shown in Fig. 34. The Mark is a solid-color region displayed similarly to that of an ROI in the spectrum. This Mark can be used to set the timing for the gate pulse. It can also be used to set the shaping times and flattop parameters to get the best performance. For example, suppose you want to get the best resolution at the highest throughput possible. By viewing the pulses and the pileup reject marker, you can increase or decrease the rise time to obtain a minimum of pileup reject pulses.

Figure 34. Mark Display Selection.

4.2.1.1. Mark Types

For the **Mark,** choose either "points" or "filled" (to the zero line) display. This is controlled by the selection in the **Display/Preferences** menu item. That choice does not affect the PHA mode choice. The colors are the same as for the PHA mode.

None No channels are marked in the display.

PileUpReject The region marked indicates when the PUR circuit has detected pileup and is rejecting the marked pulses.

NegBLDisc This shows when the negative baseline discriminator has been triggered. Typically this signal only marks the TRP reset pulse. The signal is used internally in the live-time correction, baseline restoration, and pileup rejection circuits.

BaseLineR This shows when the baseline restorer is actively restoring the baseline.

PosBLDisc This shows when the positive baseline discriminator has been triggered. The signal is used internally in the live-time correction, baseline restoration, and pileup rejection circuits.

Busy When the DSPEC 50 busy signal is active, **Busy** shows in the **Mark** box. It represents the dead time.

Gate This shows when the gate signal is present on the gate input connector. If the **Gate** mode on the ADC tab (see Fig. 36) is set to **Off**, then all regions are marked. If the mode is set to **Coincidence**, then the marked region must overlap the pulse peak (that is, must start before the beginning of the flattop and stop after the end of the flattop) for the pulse to be counted. If the mode is set to **Anticoincidence**, then the marked region will show the pulses that are accepted. That is, the rejected peaks will not be marked. Simply put, in all modes the accepted peaks are marked.

Peak This is the peak detect pulse. It indicates when the peak detect circuit has detected a valid pulse. The Mark occurs about 1.5 μs after the pulse maximum on the display.

On the lower right of the InSight display are the shaping parameter controls. The controls are split into two groups, and the **other controls...** button switches between them.

One group includes **Rise Time**, **Flattop**, **Tilt**, and the **Optimize** button. The **Rise Time** value is for both the rise and fall times; thus, changing the rise time spreads or narrows the quasi-trapezoid symmetrically.

The **Flattop** controls adjust the top of the quasi-trapezoid. The **Width** adjusts the extent of the flattop (from 0.3 to 2.4 μs). The **Tilt** adjustment varies the "flatness" of this section slightly. The **Tilt** can be positive or negative. Choosing a positive value results in a flattop that slopes downward; choosing a negative value gives an upward slope. Alternatively, **Optimize** can set the tilt value automatically. This value is normally the best for resolution, but it can be changed on this dialog and in the InSight mode to accommodate particular throughput/resolution tradeoffs. The **Optimize** button also automatically adjusts the pole-zero setting.

4.3. Amplifier PRO

This tab (Fig. 35) contains the controls for the **Low Frequency Rejector** (LFR) filter, high-frequency **Noise Rejection Level**, **Resolution Enhancer**, and **Enhanced Through-put Mode**. To enable a particular feature, mark the corresponding checkbox. Any or all of these features can be used at one time, however, the LFR and Enhanced Throughput modes must be set up before the Resolution Enhancer is configured, as discussed below. Note that once an MCB is "trained" for the **Resolution Enhancer** (see the following section), it must be "retrained" if any settings are changed that can affect peak shape or position (e.g., bias, gain, rise time, flattop, pole-zero).

Low Frequency Rejector — This feature is discussed in detail in Section 1.5. You *cannot* optimize or pole-zero the DSPEC 50 while in LFR mode. The **Optimize** feature must be used with the LFR filter *off*. Subsequent measurements can then be taken with the LFR filter on. Also, LFR mode affects the available range of protection times in **Enhanced Throughput Mode**, as discussed in the next paragraph.

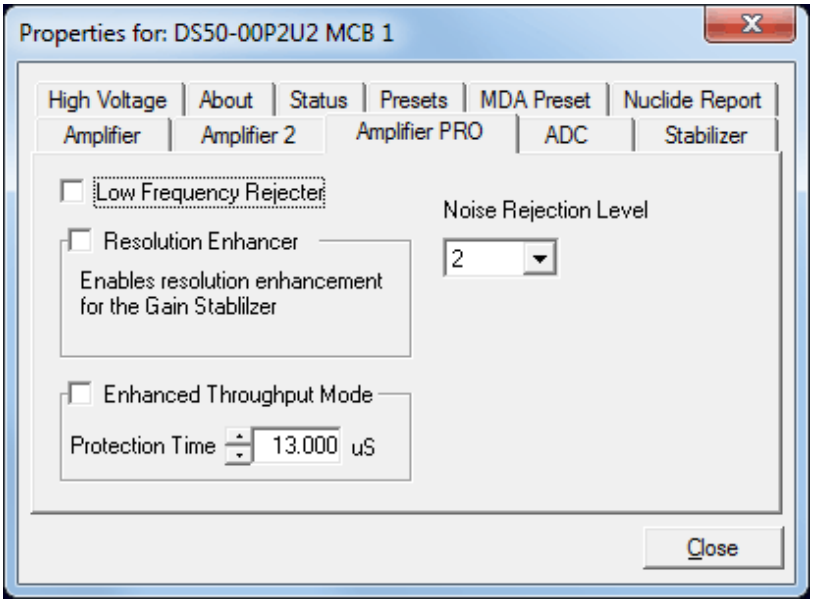


Figure 35. DSPEC 50 Amplifier PRO Tab.

Noise Rejection Level — This setting adjusts a filter that rejects high-frequency noise from the ambient environment. It ranges from 0 to 4. The default setting, **2**; will be suitable for most applications.

If the system is exhibiting high dead time with no source on the detector, the noise may be induced by nearby RF interference or a result of a ground loop. If possible, resolve the source of the noise by physical means such as common grounding between detectors and instruments, shielding cables, removing nearby motors/generators, etc. If you cannot eliminate the noise, increase the rejection level setting until the dead time returns to the expected low value.

- Note that higher values may reduce the effectiveness of the pile-up rejector when processing very low-energy pulses.

- On systems for which very high dead times are expected (i.e., >60%), especially with very-low-energy sources (e.g., ^{241}Am), decreasing this setting can improve the performance of the spectrometer with respect to live-time correction and the ability to process signals at higher input rates.

Enhanced Throughput Mode — See Section 1.4 for a discussion of this feature. The valid **Protection Time** settings, in 25-ns increments, range as follows:

LFR Mode	Highest Throughput (minimum Protection Time)	Lowest Throughput (maximum Protection Time)
Off	(Rise Time + flattop)	(2 × Rise Time + Flattop)
On	(3 × Rise Time + 2 × Flattop)	(6 × Rise Time + 3 × Flattop)

Turning on this feature automatically sets the minimum protection time (highest throughput rate) based on your current **Rise Time** and **Flattop** settings, however, you can adjust this value at any time. Each time you change the rise time or flattop, the DSPEC 50 will automatically set itself to the new minimum protection time.

4.3.1. "Training" the Resolution Enhancer

The Resolution Enhancer can help reduce the low-side peak tailing that results from increased charge trapping (but not other causes); see the discussion in Section 1.3. It operates by measuring the rise time (collection time) of the pulses and adjusting the gain based on the rise time. This is done on each pulse. The gain adjustment value for the rise time is stored in a table. The values in the table must be set by "training" the Resolution Enhancer. Marking the **Resolution Enhancer** checkbox enables/disables the "learning" mode. Note that, once trained, the enhancer operates continuously until disabled as discussed in Step (13) below. To train the enhancer:

1) Set the bias, gain, rise time, flattop, and PZ as you would for data collection.

2) If you wish to use LFR Mode, turn it on.

3) If you wish to use Enhanced Throughput Mode, turn it on and either accept the automatically calculated, highest-throughput protection time, based on the current rise time and flattop; or enter the desired setting. (The latter might require one or more data acquisitions. When finished, proceed to Step 4).

4) Clear the MCB and acquire a well-isolated peak.

5) Mark the **Resolution Enhancer** checkbox to turn on the learning mode.

6) You will now use the gain stabilization section of the Stabilizer tab to configure the Resolution Enhancer (the gain stabilizer is disabled in the learning mode). Enter the **Center** channel and **Width** of the peak acquired in Step 4; the maximum **Width** is 255 channels. If you wish, use the **Suggest** button. The selected region should be as narrow as possible but should completely include the peak.

7) Click **Initialize** to clear all the Resolution Enhancer settings. Initialization does not change the current **Center** channel and **Width**.

8) Clear the MCB, re-start acquisition, and monitor the FWHM of the target peak, using the **Peak Info** command (available by right-clicking in the spectrum window) to show the FWHM and peak counts. Collect about 5000 counts in the peak and record the FWHM. Clear the data and collect another 5000 counts, recording the FWHM. Repeat until the

FWHM no longer changes. Typically, the more charge trapping exhibited by the detector, the longer the data collection time.

9) When you are satisfied that the FWHM has reached the best possible value, clear the MCB and collect another spectrum for confirmation.

10) At this point, the Resolution Enhancer is now "trained" for the current peak shape parameters and the learning mode should be turned off by returning to the Amplifier PRO tab and unmarking the **Resolution Enhancer** checkbox. The table of adjustments will be stored in the DSPEC 50's memory.

11) If you change any parameters that affect peak shape, you must repeat this "training" procedure.

12) Once the Resolution Enhancer has been trained and its checkbox has been unmarked, the Stabilizer tab once again operates on the gain stabilizer (that is, it no longer adds values to the table of adjustments).

    NOTE The peak selected for the gain stabilizer can be different from the peak used for training the Resolution Enhancer.

13) To turn off the Resolution Enhancer, mark its checkbox to turn on the learning mode, go to the Stabilizer tab and click the **Initialize** button for the gain stabilizer. This will set the adjustment to zero. Now return to the Amplifier PRO tab and unmark the **Resolution Enhancer** box.

4.4. ADC

This tab (Fig. 36) contains the **Gate**, **ZDT Mode**, **Conversion Gain**, **Lower Level Disc**riminator, and **Upper Level Disc**riminator controls. In addition, the current real time, live time, and count rate are monitored at the bottom of the dialog.

Gate — This allows you to select a positive TTL logic gating function. With gating **Off**, no gating is performed (that is, all detector signals are processed); with gating in **Coincidence** mode, a gating input signal *must be* present at the proper time for the conversion of the event; in **Anticoincidence**, the gating input signal *must not be* present for the conversion of the detector signal. The gating signal must occur prior to and extend 500 ns beyond peak detect (peak maximum).

ZDT Mode — See Section 1.6 for a detailed discussion of this feature. Use this droplist to choose the **Off** (LTC spectrum only) or **CORR_ERR** (ERR and ZDT spectra) mode.[15] If a ZDT mode is selected, both spectra are stored in the same spectrum (.SPC) file. If you do not need the ZDT spectrum, you should select **Off**.

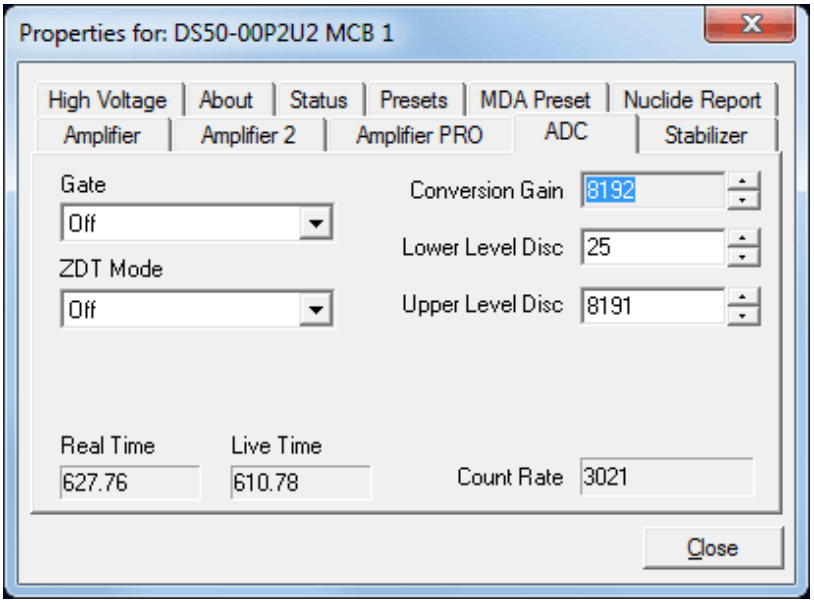


Figure 36. DSPEC 50 ADC Tab.

In MAESTRO, the spectrum window can show either of the two spectra. Use **<F3>** or **Acquire/ ZDT Display Select** to toggle the display between the two spectra. In the Compare mode, **<F3>** switches both spectra to the other type and **<Shift+F3>** switches only the compare spectrum. This allows you to make all types of comparisons.

Conversion Gain — This sets the maximum channel number in the spectrum. If set to 16384, the energy scale will be divided into 16384 channels. The conversion gain is entered in powers of 2 (e.g., 8192, 4096, 2048). The up/down arrow buttons step through the valid settings for the DSPEC 50.

Upper- and Lower-Level Discriminators — The **Lower Level Disc**riminator sets the level of the lowest amplitude pulse that will be stored. This level establishes a lower-level cutoff by channel number for ADC conversions. The **Upper Level Disc**riminator sets the level of the highest amplitude pulse that will be stored. This level establishes an upper-level cutoff by channel number for storage.

4.5. Stabilizer

The DSPEC 50 has both a gain stabilizer and a zero stabilizer (see Section D.2). The Stabilizer tab (Fig. 37) shows the current values for the stabilizers. The value in each **Adjustment** section shows how much adjustment is currently applied. The **Initialize** buttons set the adjustment to 0. If the value approaches 90% or above, the amplifier gain should be adjusted so the stabilizer can continue to function — when the adjustment value reaches 100%, the stabilizer cannot make further corrections in that direction. The **Center Chan**nel and **Width** fields show the peak currently used for stabilization.

[15] The NORM_CORR (LTC and ZDT) mode is typically not used; see Section ?.

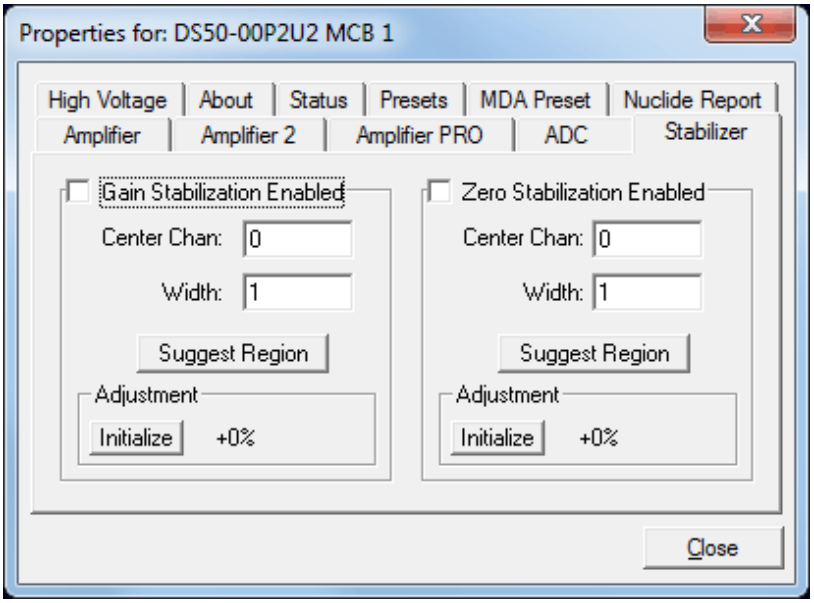


Figure 37. DSPEC 50 Stabilizer Tab.

To enable the stabilizer, enter the **Center Chan**nel and **Width** values manually or click the **Suggest Region** button. **Suggest Region** reads the position of the marker and inserts values into the fields. If the marker is in an ROI, the limits of the ROI are used. If the marker is not in an ROI: For calibrated spectra, the center channel is the marker channel and the width is 3 times the FWHM at this energy; and for uncalibrated spectra, the region is centered on the peak located within two channels of the marker and as wide as the peak. Now click the appropriate **Enabled** checkbox to turn the stabilizer on. Until changed in this dialog, the stabilizer will stay enabled even if the power is turned off. When the stabilizer is enabled, the **Center Chan**nel and **Width** cannot be changed. For more detailed information on gain and zero stabilization, see Section D.2.

4.6. High Voltage

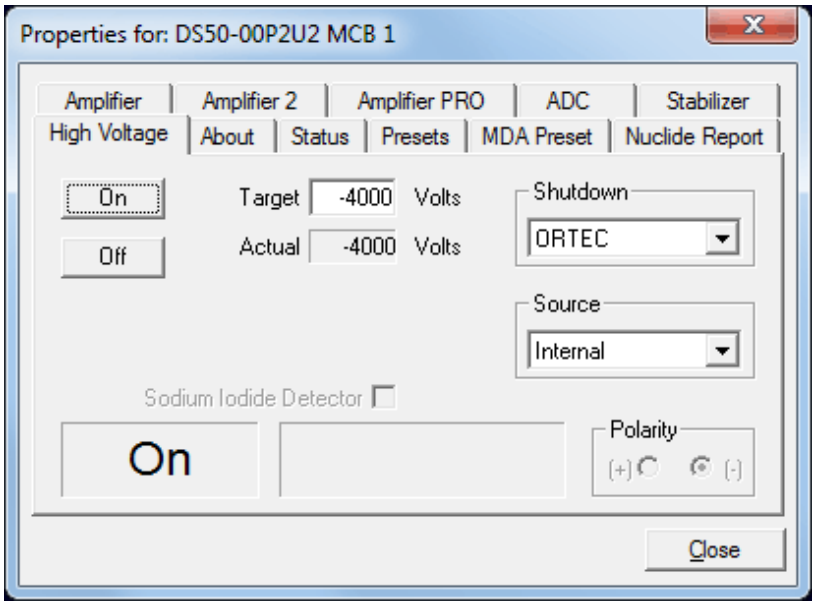


Figure 38. DSPEC 50 High Voltage Tab.

Figure 38 shows the High Voltage tab, which allows you to turn the HV on or off; set and monitor the voltage; select the HV **Source** and **Shutdown** mode; and indicate the detector type; and **Polarity**. Note that if the detector is attached via the rear-panel **DIM** connector, some of these options may be disabled or auto-selected. For example, the detector polarity is determined by the SMART-1 or DIM module.

The **Source** is **Internal** for conventional, non-DIM detectors; **DIM-296** for the Model 296, and **DIM/SMART** for all other DIM-based detectors.

NOTE NaI detectors require the DIM-POSNAI interface and the **DIM/SMART** source selection.

The shutdown types are **ORTEC**, **TTL**, and **SMART**. The **ORTEC** mode is used for all ORTEC detectors except SMART-1 (**SMART**) detectors. For non-ORTEC detectors, check with the manufacturer. The **TTL** mode is used for most non-ORTEC detectors.

Choose the detector **Polarity** (SMART-1 detectors auto-select this setting). Normally, GEM (p-type) detectors have a positive signal and GMX (n-type) detectors have a negative signal.

To use a **Sodium Iodide Detector**, mark the checkbox. This changes the gain and zero stabilizers to operate in a faster mode.

Enter the detector high voltage in the **Target** field, click **On**, and monitor the voltage in the **Actual** field. Click the **Off** button to turn off the high voltage. The HV will not turn on if the detector is sending a remote shutdown or overload signal. The Overload indicator means there is a bad connection in your system. The Shutdown indicator means that either the detector is warm, or you have chosen the wrong **Shutdown** or **Source** mode.

4.7. About

This tab (Fig. 39) displays hardware and firmware information about the currently selected DSPEC 50 as well as the data **Acquisition Start Time** and **Sample** description. In addition, the **Access** field shows whether the Detector is currently locked with a password (see the password discussion in the MAESTRO *User's Manual*), **Read/Write** indicates that the Detector is unlocked; **Read Only** means it is locked.

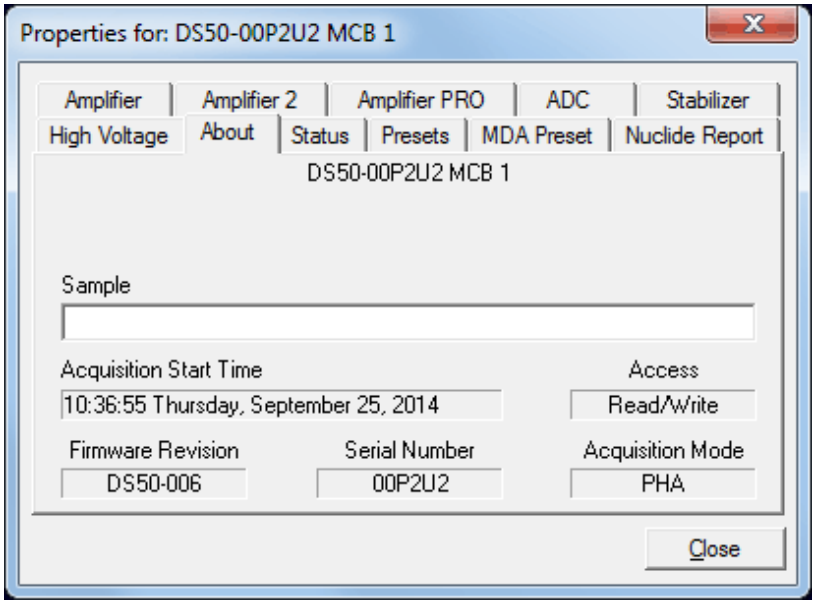


Figure 39. DSPEC 50 About Tab.

4.8. Status

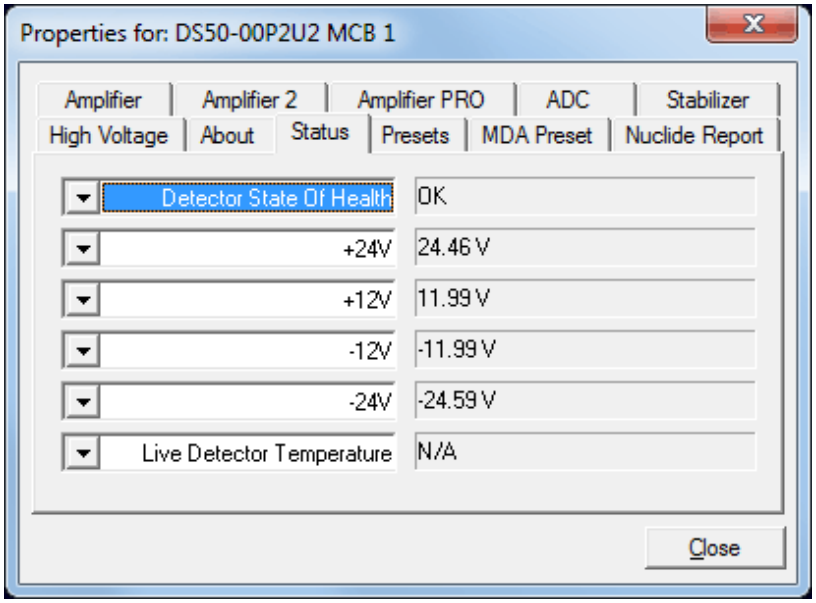


Figure 40. DSPEC 50 Status Tab.

Figure 40 shows the Status tab. You can select any six of these to be displayed simultaneously on the Status tab. The parameters you choose can be changed at any time, so you can view them as needed. Two types of values are presented: **OK** or **ERR**, and numeric value. The SOH parameters return either **OK** or **ERR**. If the state is **OK**, the parameter stayed within the set limits during the spectrum acquisition. If the parameter varied from the nominal value by more than the allowed limit, the **ERR** is set until cleared by the program. The numeric values are displayed in the units reported by the DSPEC 50. The **Security**, **Detector temperature**, and **Live detector temperature** are used by SMART-1 detectors and display **N/A** for non-SMART-1 detectors. However, in this release of the DSPEC 50, the **Detector temperature** and **Live detector temperature** return **N/A** for both SMART-1 and non-SMART-1 detectors.

Detector State of Health

Returns OK or an error message describing a problem with detector power or bias.

+24 volts

This is the current value of the +24 volt supply.

+12 volts

This is the current value of the +12 volt supply.

−12 volts

This is the current value of the −12 volt supply.

−24 volts

This is the current value of the −24 volt supply.

High Voltage

This is the current value of the high voltage bias supply.

4.9. Presets

Figure 41 shows the Presets tab. MDA presets are shown on a separate tab.

The presets can only be set on an MCB that is not acquiring data (during acquisition the preset field backgrounds are gray indicating that they are inactive). You can use any or all of the presets at one time. To disable a preset, enter a value of zero. If you disable all of the presets, data acquisition will continue until manually stopped.

When more than one preset is enabled (set to a non-zero value), the first condition met during the acquisition causes the MCB to stop. This can be useful when you are analyzing samples of widely varying activity and do not know the general activity before counting. For example, the **Live Time** preset can be set so that sufficient counts can be obtained for proper calculation of the activity in the sample with the least activity. But if the sample contains a large amount of this or another nuclide, the dead time could be high, resulting in a long counting time for the sample. If you set the **ROI Peak** preset in addition to the **Live Time** preset, the low-level samples will be counted to the desired fixed live time while the very active samples will be counted for the ROI peak count. In this circumstance, the **ROI Peak** preset can be viewed as a "safety valve."

The values of all presets for the currently selected MCB are shown on the Status Sidebar. These values do not change as new values are entered on the Presets tab; the changes take place only when you **Close** the Properties dialog.

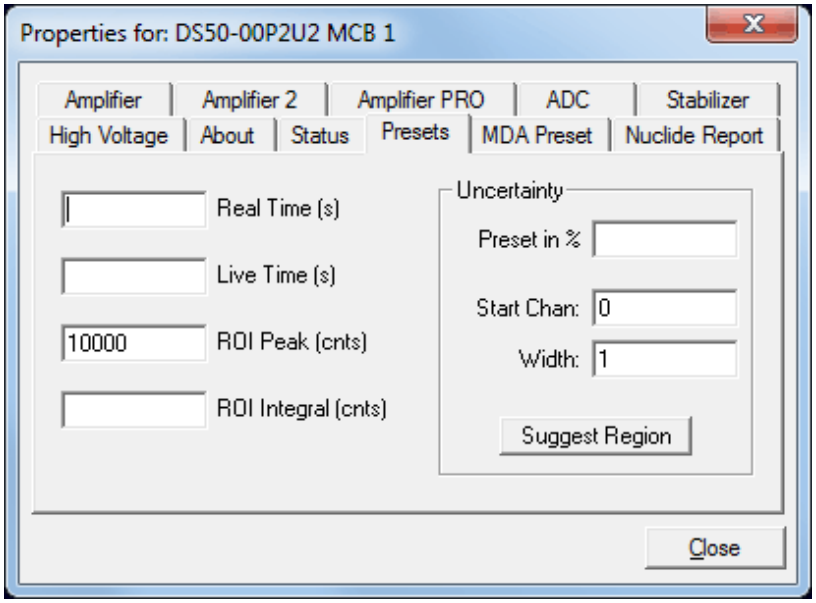


Figure 41. DSPEC 50 Presets Tab.

Enter the **Real Time** and **Live Time** presets in units of seconds and fractions of a second. These values are stored internally with a resolution of 20 milliseconds (ms) since the MCB clock increments by 20 ms. *Real time* means elapsed time or clock time. *Live time* refers to the amount of time that the MCB is available to accept another pulse (i.e., is not busy), and is equal to the real time minus the *dead time* (the time the MCB is not available).

Enter the **ROI Peak** count preset value in counts. With this preset condition, the MCB stops counting when any ROI channel reaches this value unless there are no ROIs marked in the MCB, in which case that MCB continues counting until the count is manually stopped.

Enter the **ROI Integral** preset value in counts. With this preset condition, the MCB stops counting when the sum of all counts in all ROI channels (regardless of the number of ROIs) reaches this value. This has no function if no ROIs are marked in the MCB.

The **Uncertainty** preset stops acquisition when the statistical or counting uncertainty of a user-selected net peak reaches the value you have entered. Enter the **Preset in %** value as percent uncertainty at 1 sigma of the net peak area. The range is from 99% to 0.1% in 0.1% steps. You have complete control over the selected peak region. The region must be at least 7 channels wide with 3 channels of background on each side of the peak. Note that MAESTRO calculates this preset once per 40 seconds. Therefore, the software will continue data acquisition up to 40 seconds after the preset has been reached, and the uncertainty achieved for a high count-rate sample may be lower than the preset value.

Use the **Start Chan**nel and **Width** fields to enter the channel limits directly, or click **Suggest Region**. If the marker is positioned in an ROI around the peak of interest, **Suggest Region** reads the limits of the ROI with the marker and display those limits in the **Start Chan** and **Width** fields. The ROI can be cleared after the preset is entered without affecting the uncertainty calculation. If the marker is not in positioned in an ROI: for calibrated spectra, the start channel is 1.5 times the FWHM below the marker channel, and the width is 3 times the FWHM; for uncalibrated spectra, the region is centered on the peak located within two channels of the marker and as wide as the peak.

The net peak area and statistical uncertainty are calculated in the same manner as for the MAESTRO **Peak Info** command.

4.10. MDA Preset

The MDA preset (Fig. 42) can monitor up to 20 nuclides at one time, and stops data collection when the values of the minimum detectable activity (MDA) for *all* of the user-specified MDA nuclides reach the needed value. Presets are expressed in Bq, and are evaluated every 40 seconds. The detector must be calibrated for energy in all spectroscopy applications, and for efficiency in all applications but MAESTRO.

The MDA presets are implemented in the MCB (i.e., the entries you make on this screen are saved in the MCB memory), and have no direct link to MDA methods selected in the analysis options for applications such as GammaVision, ScintiVision, ISOTOPIC, etc. The MDA preset calculation uses the following formula:

$$MDA = \frac{a + \sqrt{b + c * Counts}}{Live\ time * (CorrectionFactor)}$$

where:

a, *b*, and *c* are determined by the MDA criteria you choose.

Counts is the gross counts in an ROI that is 2.5×FWHM around the target peak energy.

Live time is evaluated in 40 second intervals for the MDA presets.

CorrectionFactor is the product of the calibration efficiency at the specified peak energy and the peak's branching ratio (yield) as listed in the working (active) library.

NOTE MAESTRO does not support efficiency calibration. The efficiency component in the *CorrectionFactor* is set to 1.0; the preset field is labeled **Correction** instead of **MDA**; and the preset is based on counting activity (**cA**) instead of becquerels. You can enter the MDA preset either in counts; or corrected for factors such as sample volume, attenuation, or calculated efficiency. For example, if you manually calculate the efficiency for a peak, you can enter a corrected MDA target value by multiplying the desired MDA value times the calculated efficiency, and entering the product as the **Correction**.

To add an MDA preset, enter the preset value in the **MDA** or **Correction** field; select the **Nuclide** and **Energy**; enter the desired values for coefficients *a*, *b*, and *c*; then click **Add New**.

To edit an existing preset, click to highlight it in the table. This will load its **Nuclide, Energy**, and coefficients in the lower sections of the dialog. Change as needed, then click **Update**.

To remove a preset, click to highlight it in the table, then click **Delete**.

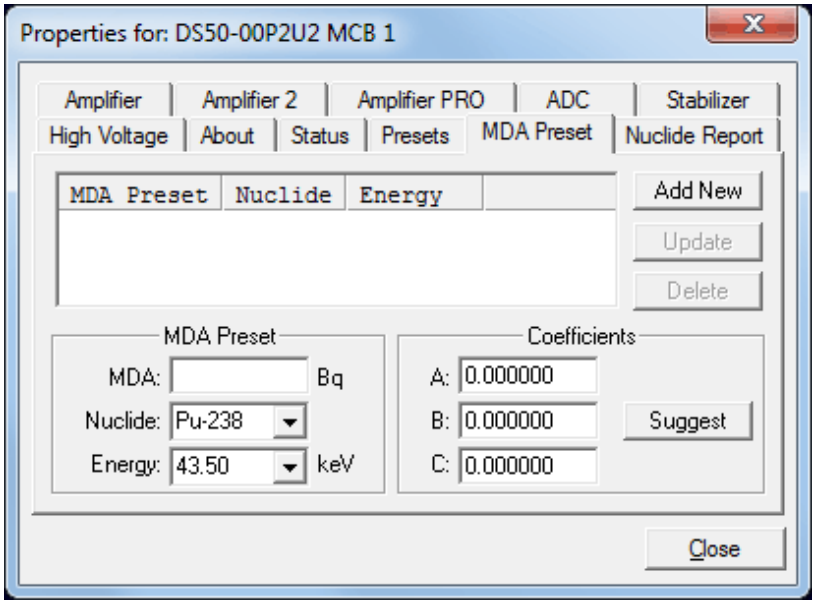


Figure 42. DSPEC 50 MDA Preset Tab.

IMPORTANT These MDA presets *are not dynamically calculated.* Each time you add an MDA preset to this table, its *CorrectionFactor* value is calculated and stored in the MCB's memory. If you then load a different library, change the efficiency calibration, or change the system geometry, the spectroscopy application *will*

not update the existing *CorrectionFactor*s, and your MDA presets may no longer be applicable.

When using spectrum analysis applications such as GammaVision and Scinti-Vision, you can create an analysis options file (.SDF or .SVD file) for each system geometry that you use; and include in it a set of MDA presets specific to that geometry, efficiency calibration, and nuclide library. You can then recall this tailored analysis options file as needed.

4.11. Nuclide Report Tab

Figure 43 shows the Nuclide Report tab. The Nuclide Report displays the activity of up to nine (9) user-selected peaks. Once the report is set up, the two lowest-energy ROIs and their respective activity readouts are displayed on the DSPEC 50's Spectrum screen.

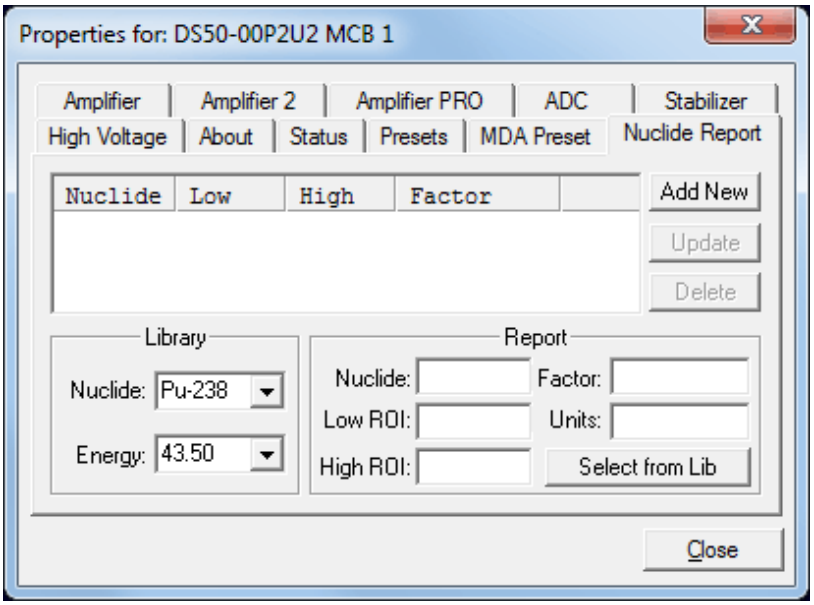


Figure 43. Nuclide Report Tab.

The peak area calculations in the hardware use the same methods as the MAESTRO **Peak Info** option (see the MAESTRO user manual), so the Nuclide Report display is the same as the **Peak Info** display on the selected peak in the spectra stored in the computer. The calculated value is computed by multiplying the net peak count rate by a user-defined constant. If the constant includes the efficiency and branching ratio, the displayed value is the activity. You enter the nuclide label and the activity units. The report format and calculations are discussed in Appendix D.

IMPORTANT The entries you make on this screen are saved in the MCB memory, and *are not dynamically calculated.* If you change the energy calibration (i.e., if the peak locations shift), the Nuclide Report may no longer be valid.

4.11.1. Add New

You can add Nuclide Peaks to the report manually or by selecting the peaks from the current working library. The spectrum must be energy calibrated to use the library method.

4.11.1.1. Defining Peaks Manually

To manually define peaks, enter the **Nuclide** name, ROI **Low** (start) and **High** (end) channels, multiplicative **Factor** and **Units** in the Report section; then click **Add New**. All nuclides in the table use the same units, so that value need only be entered once.

4.11.1.2. Selecting Peaks from the Working Library

To define report peaks using the library, select the **Nuclide** and gamma-ray **Energy** in the Library section. This defines which gamma ray to use. Now, in the Report section, click the **Select from Lib** button. Enter the **Factor** and **Units**, then click **Add New** to add this nuclide to the list. The ROI for this peak will be marked in the MCB's spectrum window, centered on the peak energy and 3 times the width of the calibrated FWHM.

4.11.2. Edit

To change any of the current nuclides, select the nuclide in the list (use the scroll bars if needed). This will show the current settings for this nuclide. Make any changes needed. Any or all of the entries can be changed. When finished with the changes, click **Update**.

4.11.3. Delete

To remove an entry, select the entry and click **Delete**.

When you close the Properties dialog, all the values entered are written to the DSPEC 50 and the two lowest-energy ROIs and corresponding activity readouts are displayed on the DSPEC 50 screen.

4.12. Setting the Rise Time in Digital MCBs

To achieve the best results when using a digital spectrometer, such as the DSPEC 50, we recommend that you set the rise time of the pulses being processed by the digital filter to the minimum value for the resolution needed.

The pulse rise time (and also fall time) is based on the time required for each pulse to reach its peak value. This "peaking time" is about twice that indicated by the conventional time constants displayed on the front panel of commercial analog amplifiers. For example, germanium detectors are often specified at a 6-µs time constant; this setting is equivalent to 12-µs peaking (rise) time in our digital spectrometers.

Up to some value of rise time, one can expect improved resolution with increasing rise time; there will, however, be a tradeoff in maximum throughput to memory. Figure 44 illustrates an example of this tradeoff. ORTEC digital spectrometers operate well above the peak of the

throughput curve. Operating there allows these instruments to handle an even higher rate of incoming counts, but with less data into memory and, therefore, a longer count time to the same detection limit. It is possible to move the peak of the curve to the right (more counts to memory with higher input count rate) by reducing the pulse rise (and fall) time, thereby trading off resolution for maximum count rate.

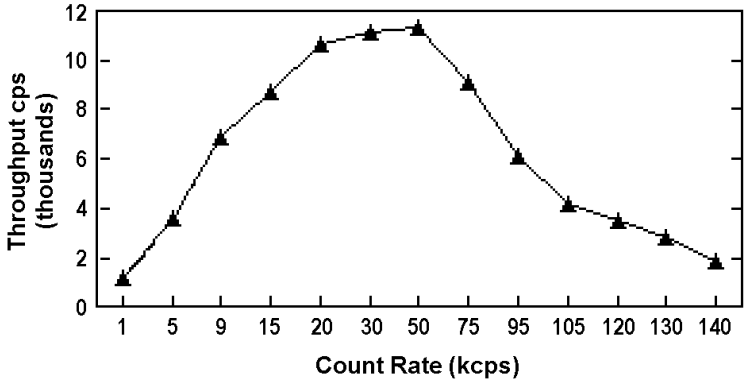


Figure 44. An Example of the Tradeoff Between Throughput and Count Rate.

Table 2 is a guide to choosing a count rate that will ensure that the most efficient operation of your digital spectrometer over the range of anticipated input count rates for your application — that is, at or below the throughput peak — while achieving the best resolution obtainable from the detector consistent with that requirement. Enter the rise time that best matches your dynamic range of count rate (note that the available rise-time settings will vary by instrument; this chart is a general guide only).

Table 2. Rise Time Selection Guide.

Input Count Rate Dynamic Range	Maximum Throughput	Rise Time (µs)
0--->20000	9000	12
0--->50000	12500	8
0--->75000	23500	4
0--->100000	37000	2.4
0--->150000	50000	1.6
0--->200k	70000	0.8
0--->220k	85000	0.6
0--->250k	100000	0.4
0--->300k	120000	0.2

The longest rise time shown in the table is 12 µs, even though some digital instruments can be set for rise times as long as 23 µs. If throughput is not an issue because all samples are low rate, increasing the rise time beyond 12 µs might achieve a small improvement in resolution. For planar detectors, such as ORTEC's GLP, Si(Li), IGLET, and IGLET-X Series, operating at longer rise times frequently gives improved resolution.

5. SPECIFICATIONS

Display Backlit, 7 in. color touchscreen, 800 × 480 pixel resolution. Provides access to the TCP/IP interface; and displays spectrum, stabilizer, bias, live-time, and dead-time readouts. In addition to the control and data display screens, you may import a maximum of 9 .JPG-format image files for timed, cyclical display.

System Gain Settings

- **Coarse Gain** 1, 2, 4, 8, 16, 32, 64, 128
- **Fine Gain** 0.5 to 1.1

The available range of gain settings supports all types of HPGe detectors. Specifically, the following maximum energy values are achievable using the standard ORTEC preamplifier (maximum to minimum gain):[16]

- COAX 187 keV–12 MeV
- GLP/SLP 16.5 keV–1 MeV

Preamplifier Software-selectable as either resistive or TRP preamplifier.

Amplifier Input Polarity Software-selectable.

System Conversion Gain Software-selectable as 16384, 8192, 4096, 2048, 1024, or 512 channels.

Digital Filter Shaping-Time Constants

- **Rise time** 0.8 μs to 23 μs in steps of 0.2 μs.
- **Flattop** 0.3 to 2.4 in steps of 0.1 μs.

Corrections

- **Dead-Time Correction** Extended live-time correction according to Gedcke-Hale method. Accuracy: area of reference peak changes <±3% from 0 to 50,000 cps.

- **Zero Dead-Time (ZDT) Correction** When ZDT mode is enabled, dead-time losses are accounted for by taking very short acquisitions and applying a correction in real time — as the data are coming in — to the number of counts in the spectrum. This technique allows the distribution of gamma-rays to change while the acquisition is in progress, yet the total counts in each of the peaks is correct. For a detailed discussion, see Section 1.6.

[16]For the legacy LO-AX and IGLET-X detector types, the respective energy ranges are 94 keV–6 MeV and 8 keV–500 keV.

- **Low-Frequency Rejector (LFR)** When ON, removes low-frequency (<3 kHz) input noise from spectrum., as discussed in Section 1.5.

- **Resolution Enhancer** Correct for charge trapping by "training" the spectrometer to accommodate the particular performance of your detector; see the discussion in Section 1.3.

- **Enhanced Throughput Mode** Protection time range from 0.1 μs to 200 μs in 25 ns increments. See Section 1.4.

LFR Mode	Highest Throughput (minimum Protection Time)	Lowest Throughput (maximum Protection Time)
Off	(Rise Time + flattop)	(2 × Rise Time + Flattop)
On	(3 × Rise Time + 2 × Flattop)	(6 × Rise Time + 3 × Flattop)

- **List Mode** In this mode, each detectable event that would normally be histogrammed as a spectrum is sent to the computer in the form of a pulse-height value along with a time stamp that indicates the time the pulse arrived. The data can be analyzed by the computer in real time to determine if some significant event has occurred, or can be streamed to disk for analysis at a later time. See Appendix E.

Linearity

- **Integral Nonlinearity** <±0.025% over top 99.5% of spectrum.
- **Differential Nonlinearity** <±1% over top 99% of range.

Digital Spectrum Stabilizer

- **Stabilization** Peak centroid (zero and gain) channel 2 to 16384; stabilization window width (zero and gain) ±1 to ±256 channels.

- **Zero Correction Resolution** ±64 channels with a minimum adjustment of 0.1 channel out of 16384 total channels.

- **Gain Correction Resolution** 0.00025% (from 99.5% to 100.5% in 4096 steps).

System Temperature Coefficient

- **Gain** <50 ppm/°C (typically <30 ppm/°C).
- **Offset** <5 ppm/°C, with rise and fall times of 12 μs and flattop of 0.8 μs (similar to analog 6 μs shaping).

Maximum System Throughput >100,000 cps with LFR off, >34,000 cps with LFR on; depends on shaping parameters.

Pulse Pileup Rejector Automatically set threshold. Pulse-pair resolution typically 500 ns. (See the discussion of the Noise Rejection Level control on page 46.)

Automatic Digital Pole-Zero Adjustment Can be set automatically or manually. Remote diagnostics via Insight Virtual Oscilloscope mode in MAESTRO.

Digital Gated Baseline Restorer Software-controlled adjustment of the restorer rate (Fast, Slow, and Auto).

LLD Digital lower-level discriminator set in channels. Hard cutoff of data in channels below the LLD setting.

ULD Digital upper-level discriminator set in channels. Hard cutoff of data in channels above the ULD setting.

Ratemeter Monitor the input count rate on the DSPEC 50 display or computer screen.

Battery Internal battery-backed up memory to maintain settings in the event of a power interruption.

Presets Multiple presets can be set on any or all of the following:

- **Real Time** Stops data collection when the real time reaches this value.
- **Live Time** Stops data collection when the live time reaches this value.
- **ROI Integral** Integral count stops data collection when the sum of counts in all ROI channels reaches this value.
- **ROI Peak** Peak count stops data acquisition when the count in any ROI channel reaches this value (maximum value of $2^{31}-1$ counts [2×10^{9}]).
- **Uncertainty** Sets the required statistical accuracy on a key peak (for example: stop counting when the activity of ^{60}Co is known to be better than 5%).
- **Multi-Nuclide MDA** Stops data collection when the value of the minimum detectable activity (MDA) for up to 20 user-specified MDA nuclides reaches the preset value. The presets are implemented in hardware so the computer does not have to poll the DSPEC 50. See Section 4.10 for details on the MDA preset calculation.

5.1.1. Inputs and Outputs

Note that each chassis (DSPEC 50 or DSPEC 502) has only one ac input power module, USB connector, Ethernet connector, SD card slot, and RESET port. Otherwise, each MCB has the following set of inputs and outputs.[17]

DIM Multi-pin connector (13W3) carries the following:

- **Preamp Power** 1 W maximum (+12V, −12V, +24V, −24V, 2 GND)
- **Analog In** Normal amplifier input
- **Inhibit** For TRP or gate
- **Battery Power** (5 V–12 V) for DIM
- **HV control**
- **SMART-1 HPGe detector control**

NOTE NaI detectors can be used with the DSPEC 50 only in conjunction with the ORTEC DIM-POSNAI interface module and the rear-panel DIM connector.

INPUT Rear-panel BNC accepts preamplifier signals of either polarity, with rise times less than the selected flat top setting and exponential decay time constant in the range of 40 μs to infinity (including TRP and pulsed-optical [POF] preamplifiers). Input impedance >500 Ω, input is dc-coupled and protected to ±12 V.

GATE IN Rear-panel BNC accepts 3.3 V (5 V tolerant) slow-positive NIM input; software-selectable as off, coincidence, or anticoincidence. ADC GATE signal must precede and overlap the flat top region by 0.5 μs, and extend beyond the flat top region by 0.5 μs. InSight Oscilloscope allows easy alignment of the ADC GATE signal with the digital output pulse.

INHIBIT IN Rear-panel BNC connector accepts 3.3 V (5 V tolerant) reset signals from TRP or POF preamplifiers. Positive NIM logic or TTL level can be used. Inhibit input initiates the protection against distortions caused by preamplifier reset. This includes turning off the baseline restorer, monitoring the overload recovery, and generating the pileup reject and busy signals for the duration of the overload. These last two signals are used internally to provide information to the dead-time correction circuitry.

PREAMP POWER Rear-panel, 9-pin D connector; provides ±24 V and ±12 V for preamplifier power.

[17]On the DSPEC 502, some input labels are abbreviated due to space constraints; e.g., SAMPLE READY IN is abbreviated as SMPL RDY, CHANGE SAMPLE IN becomes CHG SMPL, and so on.

HIGH VOLTAGE (one HV module per chassis)

- **Positive 0–5 kV** Rear-panel SHV connector, 500 V–5 kV. Computer controlled. Only active when the unit is set for positive bias.

- **Negative 0–5 kV** Rear-panel SHV connector, 500 V–5 kV. Computer controlled. Only active when the unit is set for negative bias.

SHUTDOWN IN Rear-panel BNC turns off the bias supply voltage when the detector is warm. Software-selectable ORTEC or TTL mode (SMART-1 detectors auto-select the SMART shut-down mode). In ORTEC mode, the detector Bias Shutdown must be connected to this input or the high voltage will not turn on.

CHANGE SAMPLE OUT Rear-panel BNC connector, TTL compatible.

SAMPLE READY IN Rear-panel BNC connector accepts TTL level signal from sample changer.

ETHERNET Standard 10/100 Mbit Ethernet connection. Link and Activity LEDs are integrated into the connector. Use dynamic or static IP addressing.

USB Emulates a USB connection. ORTEC CONNECTIONS software supports up to 255 USB-connected devices per computer.

SD SecureDigital™ (SD) memory card slot for uploading a maximum of 9 optional .JPG-format image files.

RESET For system maintenance performed in conjunction with the ORTEC Global Service Center.

5.1.2. Electrical and Mechanical

Dimensions 42.6 cm W × 35.6 cm D × 15.3 cm H (16.8 in. W × 14.0 in. D × 6.0 in. H).

Weight 11 kg (24.3 lbs).

Operating Temperature Range 0 °C to +50 °C, including touchscreen.

Power 100–240 V ac, 47–63 Hz, 110 watts. For 100 or 120 V ac line voltage, one fuse, 2 A (SB) size 3AG required. For 230 or 240 V ac line voltage, two fuses, 1 A(T) size 5×20 mm required.

CE Conforms to CE standards for radiated and conducted emissions, susceptibility, and low-voltage power directives.

5.2. Feature Mask Bits

The following table describes the feature bits from the SHOW_FEATURES command discussed on page 94. If the feature is supported in the DSPEC 50 the bit is set to 1; if the feature is not supported, the bit is 0.

Bit	Meaning
0	Software-selectable conversion gain
1	Software-selectable coarse gain
2	Software-selectable fine gain
3	Gain stabilizer
4	Zero stabilizer
5	PHA mode functions available
6	MCS mode functions available
7	List mode functions available
8	Sample mode functions available
9	Digital Offset (e.g., 920)
10	Software-selectable analog offset
11	HV power supply
12	Enhanced HV (SET_HV, SET/SHOW_HV_POL, SHOW_HV_ACT)
13	Software-selectable HV range (ENA_NAI, DIS_NAI)
14	Auto PZ (START_PZ_AUTO)
15	Software-selectable manual PZ (SET/SHOW_PZ)
16	Battery-backed, real-time clock (SHOW_DATE/TIME, SHOW_DATE/TIME_START)
17	Sample changer support (SET/SHOW_OUTPUT, SHOW_INPUT)
18	One-button acquisition (ENA/DIS/SHOW_TRIG_SPEC, MOVE)
19	Nomadic (likely to move between opens)
20	Local app data (SET_DATA_APP, SHOW_DATA_APP)
21	Software-retrievable serial number
22	Power management commands
23	Battery status support (SHOW_STAT_BATT)
24	Software-selectable AMP polarity (SET/SHOW_GAIN_POLAR)
25	Support for flattop optimization (ENA/DIS_OPTI)
26	Stoppable AutoPZ (STOP_PZ_AUTO)
27	Network support (e.g., DSPEC)

Bit	Meaning
28	Multi-drop serial support (e.g., MicroNOMAD®)
29	Software-selectable DPM address (SET_DPM_ADDR)
30	Multiple devices (e.g., 919)
31	Software-selectable ADC gate mode (SET_GATE...)
32	Software-downloadable firmware
33	Time histogramming functions available (e.g., 9308)
34	Software-selectable lower level discriminator
35	Software-selectable upper level discriminator
36	MCS-mode SCA input available
37	MCS-mode positive TTL input available
38	MCS-mode fast-negative NIM input available
39	MCS-mode discriminator input available
40	Software-switchable MCS-mode discriminator edge
41	Software-programmable MCS-mode discriminator level
42	Software-programmable SCA upper and lower thresholds
43	Software-selectable MCS-mode input sources
44	Uncertainty/statistical preset (SET_UNCERT_PRES)
45	Features vary by input (SHOW_FEATURES depends on device/segment;multi-input MCBs only)
46	Software-selectable HV shutdown mode (SET/SHOW/VERI_SHUT)
47	Software-selectable shaping time constants (SET_SHAP)
48	Explorable shaping time constants (SHOW_CONFIG_SHAP)
49	Advanced shaping time (SET_SHAP_RISE, SET_SHAPE_FLAT, etc.)
50	Software-selectable BLR (ENA/DIS/SHO_BLR_AUTO SET/SHO/VERI_BLR)
51	SHOW_STATUS command supported (returns $M record)
52	Overflow preset (ENA/DIS/SHO_OVER_PRES)
53	Software-enabled, MicroNOMAD-style audio clicker (ENA/DIS_CLICK)
54	Software-readable thermistor (SHOW_THERM)
55	Floating-point fine gain (SET/SHO/VERI/LIST_GAIN_FINE)
56	Software-enabled pileup rejector. (ENA/DIS/SHO_PUR, SET/VERI_WIDT_REJ)
57	Alpha-style HV power (SHOW_HV_CURRENT)
58	Software-readable vacuum (SHOW_VACUUM)
59	Acquisition alarms (ENA/DIS/SHO_ALARM)
60	Hardware acquisition trigger (ENA/DIS/SHO_TRIG)
61	Ordinal numbers for shaping times (SET_SHAP 0, SET_SHAP 1, ...)
62	Query gain ranges (LIST/VERI_GAIN_FINE, ..._COAR, ..._CONV)
63	Routable inputs (SET/SHOW_INPUT_ROUTE)

Bit	Meaning
64	External dwell support (ENA/DIS_DWELL_EXT)
65	Selectable SUM or REPLACE MCS modes (ENA/DIS_SUM)
66	External start of pass support (ENA/DIS/SHO_START_EXT)
67	Explorable with MCS list commands (LIST_SOURCE, LIST_LLSCA, LIST_ULSCA)
68	Device supports the MDA preset
69	Software-selectable ADC type (Matchmaker™)
70	Has ability to daisy-chain MCBs (DART)
71	ZDT functions available (DSPEC Plus, DSPEC jr, DSPEC jr 2.0, DSPEC Pro)
72	DSPEC Plus-style Insight triggering (LIST/SET_TRIG_SAMP)
73	Multiple inputs per connection (for example, OCTÊTE® Plus)
74	Hardware count-rate meter (SH_CRM)
75	Has multiple ZDT modes (SET/SHOW/LIST_MODE_ZDT)
76	Has multi-nuclide MDA preset
77	Has MCS Replace then Sum Mode (SET_RPLSUM)
78	Has programmable external dwell voltage capability
79	No Peak Preset feature (M^3CA and OASIS)
80	Programmable pulser (OASIS)
81	Programmable Vacuum/HV interlock (OASIS)
82	Programmable Current/HV interlock (OASIS) 0
83	Explorable Stabilizer (LIST_GAIN_ADJU, LIST_ZERO_ADJU)
84	Has programmable input impedance (MCS)
85	Advanced shaping-time feature has no CUSP (digiDART, DSPEC jr 2.0, DSPEC Pro)
86	Selectable HV rise-time (SET/SHOW/LIST_HV_RISE) (SBS-60)
87	—
88	Monitor command support (SHOW_MONI_MAX/LABEL/VALUE)
89	SMART-1 Detector support (SHOW_SMART_DET, SHOW_SNUM_DET, SHOW_HV_RECO)
90	Nuclide report (SET/SHOW_NUCL_COEF, SET/SHOW_ROI_NUCL, ...)
91	Interactive Display Features Such as Nuclide Report
92	Advanced Stored Spectra (SH_SPEC_COUNT, SET/SHOW_SPEC_ID, MOVE)
93	SET/SHOW_VIEW in MCBs with Dual-Port Memory or printer port interfaces, LIST_VIEW in all MCBs
94	Connected to MCB via RS-232 (slow) port
95	No SET_HV_POSI, SET_HV_NEGA, ENA_NAI and DIS_NAI
96	Low Frequency Rejector (ENA/DIS/SHOW_LFR)
97	Resolution Enhancer (ENA/DIS/SH_RENHANCER, SET/SHOW_RETABLE idx,val)
98	SET_MODE_RELIST for Resolution Enhancer List Mode

Bit	Meaning
99	Readable Sample mode time per channel (SH_TIME_SAMPLE)
100	Adjustable Sample mode time per channel (SET/LIST_TIME_SAMPLE)
101	List Mode data streamed and formatted as in digiBASE
102	Supports ETP mode (ENA/DIS/SHOW_ETP)
103	List Mode data streamed and formatted as in DSPEC PRO
104	SET/SHOW/LIST_PZ using floating point microseconds
105	Rise time, flattop width, and cusp not user changeable from property page
106	High Voltage not user changeable from property page
107	Coarse and fine gain not user changeable from property page
108	PZ and flattop tilt not user changeable from property page
109	LFR not user changeable from property page
110	Synch List Mode is available
111	DSPEC-PRO auxiliary BNC input available
112	SET_DISPLAY is NOT used to select ZDT data view
113	ID Reports (DO_ID, SHOW_REPORT, SHOW_REPO_LINES)
114	Has neutron detector (SHOW_CRM 2 returns valid number)
115	—
116	—
117	Selectable HV source
118	—
119	—

[Intentionally blank]

6. FIRMWARE COMMANDS AND RESPONSES

Most software communication with the DSPEC 50 will take place through the CONNECTIONS software layer. CONNECTIONS is used by all ORTEC software and can be accessed for other software development with our CONNECTIONS Programmer's Toolkit with Microsoft ActiveX® Controls (A11). Use the DLL interface call MIOComm or the ActiveX control UCONN's Comm method to send commands to instruments and receive responses.

- **Ethernet interface** — Communication consists of sending command records to the MCB API and receiving response records from the MCB API. Both command and response records consist of a sequence of printable ASCII characters followed by an ASCII carriage return. All commands eventually respond with a percent response record — so named because the response begins with an ASCII percent sign "%" — which signifies the completion of the command (Section 6.1.3). SHOW and STEP commands respond with a dollar response record (which begins with an ASCII dollar sign "$") followed by a percent response record (Section 6.1.4). All other commands result in a single percent response record upon completion.

- **USB interface** — Error codes are discussed in Section 6.1.2. SHOW and STEP commands respond with a dollar response record (Section 6.1.4).

6.1.1. Command Records

Commands consist of a command header that may be followed by numeric parameter values. The header consists of a verb or a verb and noun separated by an underscore; or a verb, noun, and modifier, each separated by underscores. The first four letters of a word in a command will always be enough to uniquely identify that word when composing commands for the instrument. For example, the command **ENABLE_GAIN_STABILIZATION** can be abbreviated to **ENAB_GAIN_STAB**.

Numeric parameters are unsigned integer numbers that follow the command header separated by one or more spaces. Specific commands require multiple parameters, separated by commas, that specify numeric quantities related to the operation of the MCB, such as live time or conversion gain. The command **SET_WINDOW 0,8192** has two parameters, 0 and 8192, which set the window of interest to start at channel 0 and continue for 8192 channels.

Some parameters are optional and are delimited by square brackets in the command prototype line to distinguish them from mandatory parameters (e.g., SET_WINDOW [start,length]). Commands with optional parameters can be sent to the MCB without the optional parameters, in which case the instrument behavior will be explained in the command description.

For commands across the Ethernet interface, an optional checksum may be added to the end of any command sent to MCB API. The checksum is a 1-byte unsigned integer sum of all of the characters in a command, treated as unsigned integers, up to and including the comma or space(s) that separates the checksum from the command. The checksum simply appears as an extra parameter added to the end of the command parameter list. For commands that do not normally have parameters, the checksum appears as the only parameter separated from the header by one or more spaces. All optional parameters must be included in a command if a checksum is to be provided so that the checksum is not mistaken by the MCB API as a parameter. For example, the SET_WINDOW command must include the two optional parameters, start and length, if the checksum is provided (e.g., **SET_WINDOW 0,16384,209**).

6.1.2. USB-Interface Error Codes

On each completion of the command, the MCB returns a macro error code and micro error code. The macro error code represents the general class of error with 0 meaning no error, and the micro error code represents the sub-class of error with 0 meaning no error. In case of error condition, you can use the MIOGetLastError (DLL interface) or GetErrMajor, GetErrMinor (ActiveX control interface).

Macro error codes:

0	Success
1	Power-up just occurred
2	Battery-backed data lost
129	Command syntax error
131	Command execution error
132	Invalid Command

For macro code 129 (syntax error) or 131 (execution error), the following apply:

1	Invalid Verb
2	Invalid Noun
4	Invalid Modifier
128	Invalid first parameter
129	Invalid second parameter
130	Invalid third parameter
131	Invalid fourth parameter
132	Invalid number of parameters
133	Invalid command

134	Response buffer too small
135	Not applicable while active
136	Invalid command in this mode
137	Hardware error
138	Requested data not found

Micro error codes:

0	Success
1	Input already started/stopped
2	Preset already exceeded
4	Input not started/stopped
64	Parameter was rounded (for decimal numbers)
128	No sample data available

6.1.3. Percent Response Records

The MCB API responds to all commands with a percent response record that signifies the completion of the command. Percent response records contain two error code numbers and a 1-byte checksum as follows:

%aaabbbccc<CR>

where % represents the ASCII % character, **aaa** represents the macro error code, **bbb** represents the micro error code, **ccc** represents the checksum and <CR> represents the ASCII carriage return character signifying the end of the record. The macro error code represents the general class of error with 0 meaning no error, and the micro error code represents the sub-class of error with 0 meaning no error. Following is a list of all percent responses for the DSPEC 50.

Unconditional Success:

%000000069<CR> No errors detected. Command executed as specified.

%000005074<CR> Device already started or stopped. The START or STOP command was ignored.

%000006075<CR> Device preset already exceeded. The START command was ignored.

%000016076<CR> START requested but amplifier not pole-zeroed since last power-up. START was attempted anyway.

%000032074<CR> START requested but high voltage not enabled START was attempted anyway.

%000064079<CR> Specified parameter was rounded to the closest legal value.

Note that the above responses can be combined to indicate a combination of warnings such as:

%000048081<CR> Amplifier was not pole-zeroed nor was high voltage enabled. The START was attempted anyway.

%000037079<CR> Device already started and high voltage not enabled. The command was ignored.

%000053077<CR> Device already started, high voltage not enabled and amplifier was not pole-zeroed. The command was ignored.

%000038080<CR> Device preset already exceeded and high voltage not enabled. The command was ignored.

%000054078<CR> Device preset already exceeded, high voltage not enabled and amplifier was not pole-zeroed. The command was ignored.

Power-Up Alert: Power-up just occurred and the selftest results are:

%001000070<CR> All power-up selftest passed.

%003000072<CR> Battery backed-up data lost.

Command Syntax Errors:

%129001082<CR> Invalid command verb.

%129002083<CR> Invalid command noun.

%129003084<CR> Invalid command verb and noun.

%129004085<CR> Invalid command modifier.

%129005086<CR> Invalid command verb and modifier.

%129006087<CR> Invalid command noun and modifier.

%129007088<CR> Invalid command verb, noun, and modifier.

%129132087<CR> Invalid command (verb, noun, and modifier valid but not together).

Communication Errors:

%130128084<CR> Command checksum incorrect (only when optional checksum provided).

Execution Errors:

%131128085<CR> Invalid 1st command parameter.

%131129086<CR> Invalid 2nd command parameter.

%131130078<CR> Invalid 3rd command parameter.

%131132080<CR> Invalid number of command parameters.

%131134082<CR> Invalid device or segment selected.

%131135083<CR> Command not allowed while acquisition in progress.

%131136084<CR> Command not allowed in current mode of operation.

%131137085<CR> Hardware failure detected while processing command.

6.1.4. Dollar Response Records

SHOW and STEP commands respond with a single dollar response record followed immediately by a percent response record. All valid dollar response records for each command are listed in the command dictionary.

The following list provides the general form of each dollar response record for the MCB API. In this list, lower case letters represent numeric values. The letters "**ccc**" always represent an 8-bit unsigned checksum of all characters on the record up to but not including the checksum characters, and **<CR>** represents the ASCII carriage return character.

$Axxxccc<CR>	xxx is a single 8-bit unsigned number.
$Cxxxxxccc<CR>	xxxxx is a single 16-bit unsigned number.
$Dxxxxxyyyyyccc<CR>	xxxxx and yyyyy are 16-bit unsigned numbers.
$Exxxxxccc<CR>	xxxxx is a single 16-bit alarm mask.
$Fssss...<CR>	ssss... is a variable length ASCII character sequence (no checksum is sent with this record).
$Gxxxxxxxxxxccc<CR>	xxxxxxxxxx is a single 32-bit unsigned number.
$IT<CR>	True response to a SHOW command (no checksum).
$IF<CR>	False response to a SHOW command (no checksum).
$Jxxxxxyyyyy...ccc<CR>	Response to SHOW_CONFIGURATION command.
$Mxxxxxxxxxx...ccc<CR>	Response to SHOW_STATUS command.
$Nxxxyyyzzzccc<CR>	xxx, yyy, and zzz are 8-bit unsigned numbers.

6.1.5. Command Catalog

This section lists each command with a description of its operation. The descriptions include a list of any unusual responses that may result. The no-errors response from a command is a **%000000069<CR>** (Ethernet interface); or a macro error code of 0 and a micro error code of 0 (USB interface). Though syntax and communication error responses may result from any command, in practice, these error responses rarely occur on systems with reliable communication hardware running debugged software.

The commands are listed in alphabetical order, each starting with a command prototype line. Uppercase letters, numeric digits, blank space, and special symbols such as the underscore "**_**" and comma 13 "**,**" in the prototype line are *literal text to be sent to the MCB exactly as they appear*. Lowercase letters in the prototype line represent numeric values as described in the accompanying text; they should not be sent literally to the MCB but should be *replaced by an appropriate numeric value*. Lower-case letters enclosed in quotes represent *alphanumeric character strings* rather than numerical values. Items in the command prototype that are sur-

rounded by square brackets "[...]" are optional items and are not always required. In this section the term **<CR>** represents the ASCII carriage return character, decimal value 13, and the character "_" represents the ASCII underscore character, decimal value 95.

CLEAR

The channels of spectral data in the window of interest (see SET_WINDOW command) are set to zero. The live time and true time counters are also set to zero. This command is equivalent to the combination of CLEAR_COUNTER and CLEAR_DATA commands.

CLEAR_ALL

This command is equivalent to the combination of CLEAR_COUNTER, CLEAR_DATA, CLEAR_PRESETS, and CLEAR_ROI commands.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

CLEAR_COUNTER

The live time and true time counters are set to zero.

CLEAR_DATA

The channels of spectral data in the window of interest (see SET_WINDOW command) are set to zero. The ROI flags are not changed, nor are the presets changed.

CLEAR_LIST

Clears data and resets acquisition in List Mode. The response is the same as the CLEAR command.

CLEAR_MDA_PRESET

Clears all MCA preset values. This command is used to quickly clear the list of MDA preset values.

CLEAR_PRESETS

The live time, true time, ROI integral, and ROI peak presets are all set to zero (disabled).

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

CLEAR_ROI

The region-of-interest flags for the channels in the window of interest (see SET_WINDOW command) in the currently selected device (see SET_DEVICE command) are cleared.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

COMPUTER

No function in the DSPEC 50; included for backward compatibility.

DISABLE_BLRE_AUTOMATIC

Disables the automatic determination of baseline restorer time constant. See also ENABLE_BLRE_AUTOMATIC, SET_BLRE, and SHOW_BLRE.

DISABLE_ETP

Returns the DSPEC 50 to normal operation if in Enhanced Throughput (ETP) mode. See also ENABLE_ETP, SHOW_ETP, SET_TIME_ETP, LIST_TIME_ETP, and SHOW_TIME_ETP.

DISABLE_GAIN_STABILIZATION

Stops stabilization of the gain peak while data is being acquired. The gain stabilization adjustment is held at its current value until either gain stabilization is reenabled with the ENABLE_GAIN_STABILIZATION command or reinitialized with the INITIALIZE_GAIN_ STABILIZATION, SET_GAIN_PEAK or SET_GAIN_WIDTH command. See also SHOW_GAIN_STABILIZATION.

DISABLE_HV

Turns off the high-voltage enable signal of the DSPEC 50. See the section on the bias supply for more information about the high-voltage output. See also ENABLE_HV and SHOW_HV.

DISABLE_HV_DIM

Disables the use of the DIM connector on the back of the DSPEC 50 and causes the DSPEC 50 to suppress SOH information (see SHOW_HV_HEALTH command). Also, the command disables polling of a standard DIM module (e.g. DIM-POSNAI, DIM-POSGE, DIM-NEGGE, or DIM-296) by the DSPEC 50.

DISABLE_LFR

Returns the DSPEC 50 to normal operation if the LFR filter is enabled. See also ENABLE_LFR and SHOW_LFR.

DISABLE_NAI

Switches the stabilizers to Ge mode. See ENABLE_NAI.

DISABLE_OPTI_NEED
Disables the reporting of an error when the DSPEC 50 has not been optimized.

DISABLE_PZ_AUTOMATIC
Disables the automatic pole zero mode. See also ENABLE_PZ_AUTOMATIC.

DISABLE_PZ_NEED
Disables the reporting of an error when the DSPEC 50 has not been pole zeroed.

DISABLE_REMOTE
No function in the DSPEC 50; included for backward compatibility.

DISABLE_RENH
Returns the DSPEC 50 to normal operation if the Resolution Enhancer is enabled. See ENABLE_RENH.

DISABLE_THRESHOLD_AUTOMATIC
DISABLE_THRESHOLD_SAMPLE
DISABLE_TRIGGER_SPECIAL
No function in the DSPEC 50; included for backward compatibility.

DISABLE_TRIGGER
Disables the data acquisition trigger that was enabled by the ENABLE_TRIGGER command. Cancels an ENABLE_TRIGGER_REP if it is issued before the acquisition starts. See ENABLE_TRIGGER, TRIGGER, and SHOW_TRIGGER.

DISABLE_ZERO_STABILIZATION
Stops stabilization of the zero peak while data is being acquired. The zero stabilization adjustment is held at its current value until either zero stabilization is reenabled with the ENABLE_ZERO_STABILIZATION command or reinitialized with the INITIALIZE_ZERO_ STABILIZATION, SET_ZERO_CHANNEL or SET_ZERO_WIDTH commands. See also SHOW_ZERO_STABILIZATION.

DISABLE_ZDT
Returns the DSPEC 50 to normal operation if in zero-dead-time (ZDT) mode. See ENABLE_ZDT.

ENABLE_BLRE_AUTOMATIC
Enables the automatic determination of baseline restorer time constant. See also DISABLE_BLRE_AUTO, SHOW_BLRE, and SET_BLRE.

ENABLE_ETP

Sets the DSPEC 50 to Enhanced Throughput (ETP) mode. See also DISABLE_ETP, SHOW_ETP, SET_TIME_ETP, LIST_TIME_ETP, and SHOW_TIME_ETP.

ENABLE_GAIN_STABILIZATION

Enables the stabilization of the gain peak. See also DISABLE_GAIN_ STABILIZATION, SHOW_GAIN_STABILIZATION, and INITIALIZE_GAIN_STABILIZATION.

ENABLE_HV

Turns on the high-voltage enable output of the DSPEC 50. See also DISABLE_HV and SHOW_HV.

Non-USB Execution Errors:

%131137085<CR>	The high voltage could not be enabled due to a high voltage shutdown condition.

ENABLE_HV_DIM

Enables the DSPEC 50 to work with a standard DIM (e.g. DIM-POSNAI, DIM-POSGE, or DIM-NEGGE, DIM-296). This command enables the DSPEC 50 to poll the DIM and causes the DSPEC 50 to return SOH information to a controlling program (see SHOW_HV_HEALTH command).

ENABLE_LFR

Sets the DSPEC 50 to LFR mode. See also DISABLE_LFR and SHOW_LFR.

ENABLE_NAI

Switches the stabilizers to NaI mode. The stabilizers use the “fine” adjustment in NaI mode and the “very fine” adjustment in Ge mode. See DISABLE_NAI.

ENABLE_OPTI_NEED

Enables the reporting of an error when the DSPEC 50 needs optimizing.

ENABLE_PZ_AUTOMATIC

Enables the automatic pole zero mode. See also DISABLE_PZ_AUTO and SHOW_PZ_AUTO.

ENABLE_PZ_NEED

Enables the reporting of an error when the DSPEC 50 needs pole zeroing.

ENABLE_REMOTE

No function in the DSPEC 50; included for backward compatibility.

ENABLE_RENH

Sets the DSPEC 50 to Resolution Enhancer mode. See also SHOW_RENH.

ENABLE_THRESHOLD_AUTOMATIC

Enables automatic determination of the positive and negative thresholds. See also DISABLE_THRESHOLD_AUTO, SHOW_THRESHOLD_AUTO, SET_THRESHOLD_NEGATIVE, and SET_THRESHOLD_POSITIVE.

ENABLE_THRESHOLD_SAMPLE
ENABLE_TRIGGER_SPECIAL

No function in the DSPEC 50; included for backward compatibility.

ENABLE_TRIGGER

Enables the Sample Ready connector. Acquisition will then start when an external trigger occurs on the Sample Ready connector or when the TRIGGER command is issued. See also TRIGGER, DISABLE_TRIGGER, SHOW_TRIGGER, SET_TRIGGER_POLARITY, and SHOW_TRIGGER_POLARITY.

ENABLE_ZDT

Sets the DSPEC 50 to ZDT mode. See SET_MODE_ZDT for information on selecting the ZDT mode.

ENABLE_ZERO_STABILIZATION

Enables the stabilization of the zero peak. See also DISABLE_ZERO_ STABILIZATION, SHOW_ZERO_STABILIZATION, and INITIALIZE_ZERO_STABILIZATION.

INITIALIZE

Returns the DSPEC 50 (including flash) to the factory default settings. ***CAUTION: If using the DIM connector, turn off the detector bias and physically disconnect the DIM cable from the DSPEC 50 rear panel before issuing this command.***

Non-USB Execution Errors:

The INITIALIZE command simulates a power-down/power-up cycle for the MCB after a simulated loss of battery-backed-up memory.

Response:

%003000072<CR>	MCB Power-up occurred/Memory lost/No selftest errors (Normal Response for INITIALIZE command).

INITIALIZE_GAIN_STABILIZATION

Resets the gain peak stabilization adjustment to unity (no adjustment). This value is reported as 2048 by the SHOW_GAIN_ADJUSTMENT command. See also SET_GAIN_ADJUSTMENT, ENABLE_GAIN_ STABILIZATION, and DISABLE_GAIN_STABILIZATION.

INITIALIZE_ZERO_STABILIZATION

Resets the zero peak stabilization adjustment to unity (no adjustment). This value is reported as 2048 by the SHOW_ZERO_ADJUSTMENT command. See also SET_ZERO_ADJUSTMENT, ENABLE_ZERO_STABILIZATION, and DISABLE_ZERO_STABILIZATION.

LIST_BLRE

Lists the valid settings of the baseline restore function. See also SET_BLRE.

Response:

BLRE 10.0 100.0 10 100 Legal settings are 10.0 to 100.0 in steps of 1.

LIST_CORR_FLAT

Lists the valid settings of the flattop width. See also SET_CORR_FLAT.

Response:

CORR_FLAT –1.0 .992 0 255 Legal settings are from –1 to 0.992 in (255 – 0 + 1 = 256) steps.

LIST_DISPLAY

Not used by the DSPEC 50; included for backward compatibility.

LIST_GAIN_COARSE

Lists the valid coarse-gain settings.

Response:

GAIN_COAR 1 2 4 8 16 32 64 128

LIST_GAIN_CONV

Lists legal conversion gain settings.

Response:

GAIN_CONV 512 1024 2048 4096 8192 16384

LIST_GAIN_FINE

Lists the valid fine-gain settings.

Response:

GAIN_FINE 0.45 1.0 88437 196607 0.45 to 1 in 108171 steps.

LIST_HV

Lists the valid high-voltage settings.

Response:

HV 0 5000 0 5000 0 to 5000 in 5000 steps.

LIST_MODE_ZDT

Reports the legal ZDT-mode settings. Each item in the list can be selected by sending the SET_MODE_ZDT command with a mode number. The mode number is implied by the location of the mode in the list. For example, the first item in the list had a mode number of 0. To select the first item, send SET_MODE_ZDT 0. The second item has a mode number of 1, and so on.

Response:

MODE_ZDT NORM_CORR CORR_ERR Mode 0 stores the normal and corrected spectra. Mode 1 stores the corrected and the error spectra.

LIST_ROI_SAMPLE

Lists the valid ROI sample settings.

Response:

ROI_SAMP PUR BLN BLRG BLD BUSY GATE RESV PKDET

LIST_SHAP_CUSP

Not used by the DSPEC 50; included for backward compatibility.

LIST_SHAP_FLAT

Lists the valid flattop width settings.

Response:

SHAP_FLAT 0.3 2.4 3 24 Settings are 0.3 to 2.4 in 22 steps of 0.1 μs.

LIST_SHAPE_RISE

Lists the valid rise-time settings.

Response:

SHAP_RISE 0.8 23.0 4 115 Settings are 0.8 to 23 in 0.2-μs steps.

LIST_SHUT

Lists the valid shutdown settings.

Response:

SHUTDOWN TTL ORTEC SMART

LIST_TIME_ETP

Returns the range of valid protection-time settings in the Enhanced Throughput Mode.

Response:

TIME_ETP 01 200 4 8000 Valid settings range from 0.1 μs to 200 μs in 25-ns increments.

LIST_TRIGGER_SAMPLE

Lists the valid trigger sources in Insight (sample) mode.

Response:

TRIG_SAMP LLD PKD Random Gate

SET_BLRE baseline

This sets the baseline restorer time constant to the value baseline. Baseline is in micro-seconds with a range from 10 to 100. The specified value is only used if automatic baseline restorer mode is disabled. See also ENABLE_BLRE, DISABLE_BLRE, and SHOW_BLRE.

Execution Warnings:

%000064079<CR> Value was rounded to the closest legal value.

SET_CORRECTION_FLAT value

This sets the flattop correction to value. The flattop correction is normally determined with the OPTIMIZE command. See also SHOW_CORRECTION_FLAT.

SET_DATA [start, chans],value

If the optional start and chans parameters are included in this command, the range of channels specified by start and chans is loaded with value. If start and chans are not specified, sets all channels of spectral data in the window of interest (see SET_WINDOW command) to the specified value. ROI flags are not affected.

SET_DATA_APPLICATION “string1",”string2"

This is used to store information in the DSPEC 50 internal memory that can be used by other programs, such as sample descriptions and energy calibrations. The Unified MCB Interface (UMCBI) structure and ORTEC CONNECTIONS make use of this feature. String1 = the data identifier, 32 bytes maximum; string2 = the data, 128 bytes maximum.

SET_DATE day,month,year

Sets the date stored in the battery backed-up system clock to the specified values. Day can be any value from 1–31; month any value from 1–12; and year any value from 0–99. The current date and time are stored for a device when an acquisition is started. See also SHOW_ DATE, SET_TIME, and SHOW_TIME.

SET_DATE_START day,month,year

Sets the start date to the specified values. Normally the start date and time are set automatically whenever a device is started with the START command. See also SHOW_DATE_START, SET_TIME_START, and SHOW_TIME_START.

SET_DELAY_COLLECTION value

Controls the pileup rejector by setting a width threshold such that if a fast channel discriminator pulse is wider than value, the pulse is rejected. This portion of the pileup rejector rejects pulses that are too close together to be detected separately by the fast channel. Value is in microseconds with a range from 0.250 to 1.6 in steps of 0.05. See also SHOW_DELAY_COLLECTION.

SET_DELAY_SAMPLE num

Delays the waveform collected in InSight mode by num points. Num must be between 0 and 65535. See also SHOW_DELAY_SAMPLE.

SET_DEVICE
SET_DISPLAY

No function in the DSPEC 50; included for backward compatibility.

SET_GAIN_ADJUSTMENT value

Sets the gain stabilization adjustment to an arbitrary value from −65535 to 65535. This adjustment is usually made only by the gain stabilizer, and reset to 0 with the INITIALIZE_GAIN_STABILIZATION command. See also SHOW_GAIN_ADJUSTMENT.

Non-USB Execution Errors:

%131134082<CR>	The command was attempted when the currently selected device was other than device 1.

SET_GAIN_CHANNEL chan

Sets the center channel for the stabilizer gain peak. If a gain channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel as determined by the conversion gain, the gain peak width is reduced until the peak fits the device boundaries. A gain channel and width must be set before gain stabilization can be enabled.

Non-USB Execution Errors:

%131128085<CR>	The specified channel number would create a peak that was less than the minimum width (3 channels) or would be outside the device's range.
%131136084<CR>	The command was attempted while gain stabilization was enabled.

SET_GAIN_COARSE num

This sets the coarse gain to num, which must be 1, 2, 4, 8, 16, 32, 64, or 128. See also SHOW_GAIN_COARSE.

SET_GAIN_CONVERSION chans

Sets the conversion gain. The conversion gain defines the number of channels within the device that will used for spectral data. This has the effect of altering the resolution of the ADC from 14 bits (conversion gain = 16384) to 9 bits (conversion gain = 512) for the device. See also SHOW_GAIN_CONVERSION.

Legal Commands:

SET_GAIN_CONVERSION 0<CR>	Conversion gain set to default (16384).
SET_GAIN_CONVERSION 512<CR>	Conversion gain set to 512 channels.
SET_GAIN_CONVERSION 1024<CR>	Conversion gain set to 1024 channels.
SET_GAIN_CONVERSION 2048<CR>	Conversion gain set to 2048 channels.
SET_GAIN_CONVERSION 4096<CR>	Conversion gain set to 4096 channels.
SET_GAIN_CONVERSION 8192<CR>	Conversion gain set to 8192 channels.
SET_GAIN_CONVERSION 16384<CR>	Conversion gain set to 16384 channels.

SET_GAIN_FINE value

Sets the fine gain to value. Value is a floating point value from 0.5 to 1.1. See also SHOW_ GAIN_FINE.

SET_GAIN_NEGATIVE

Sets the amplifier input polarity to negative.

SET_GAIN_POSITIVE

Sets the amplifier input polarity to positive.

SET_GAIN_PRESET count

No function in the DSPEC 50; included for backward compatibility.

SET_GAIN_WIDTH chans

Sets the width in channels for the stabilizer gain peak. The gain width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The gain channel and width must be set before gain stabilization can be enabled. The absolute minimum width for the gain peak is 3 channels, and the absolute maximum width for the gain peak is 256 channels in Gauss mode. In point mode there is no maximum peak width, though the chosen width must allow the peak to fit within the device's channel limits as stated above. See also SHOW_GAIN_WIDTH, SET_GAIN_CHANNEL and SHOW_GAIN_CHANNEL.

Non-USB Execution Errors:

%131128085<CR>	The specified number of channels would create a peak that was less than the minimum (3 channel) width or would be outside the device's range.
%131136084<CR>	The command was attempted while gain stabilization was enabled.

SET_GATE_ANTICOINCIDENT

Causes the DSPEC 50 to use the ADC gate input signal in anticoincident mode. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SHOW_GATE.

SET_GATE_COINCIDENT

Causes the DSPEC 50 to use the ADC gate input signal in coincident mode. See also SET_ GATE_OFF, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

SET_GATE_OFF

Causes the DSPEC 50 to ignore the state of the ADC gate input signal. See also SET_ GATE_COINCIDENT, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

SET_HV value

This sets the HV bias to value, in volts.

SET_ID "id string"

Sets the sample id string. This string can be up to 16 characters long and can be set to any arbitrary value. The id string is intended to uniquely identify the sample being analyzed. See also SHOW_ID.

Non-USB Execution Errors:

%131132080<CR>	No ID string was specified. No action was taken.

Example:

SET_ID "Site 123"

SET_INTEGRAL_PRESET count

Sets the ROI integral preset to the specified count. During data acquisition when the sum of the counts contained in the channels that have the ROI flag set reaches the integral preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI integral may exceed the preset value by up to 512 counts due to the pipelined architecture of the DSPEC 50. Setting an integral preset to 0 counts disables the preset. The integral preset may be set to from 0 (disabled) to 4294967295 counts. See also CLEAR_ PRESETS and SHOW_INTEGRAL_PRESET.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_LENGTH_SAMPLE length

Sets the number of points in the Insight mode display to the specified value. Normally this setting would remain at 1000.

SET_LIVE ticks

Sets the live-time counter to the specified number of ticks. The number represents live time in units of 20 ms (50 ticks/s). Normally this value is set by the DSPEC 50 during data acquisition. See also CLEAR_COUNTER and SHOW_LIVE.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_LIVE_PRESET ticks

Sets the live-time preset to the specified number of ticks (20 ms/tick). During data acquisition when the live-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a live-time preset to 0 ticks disables the preset. See also CLEAR_PRESETS and SHOW_LIVE_PRESET.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_LLD chan

Sets the lower level discriminator to chan, which must be between 0 and 16383. See also SHOW_LLD.

SET_MDA_COEF a,b,c

Sets the coefficients in the MDA preset calculation to the specified values. A, b, and c are floating-point values. The MDA preset checks for the following condition to be met:

$$MDA\ Preset_i > \frac{a + \sqrt{b + c * CountsinROI_i}}{Live\ Time}$$

The calculation is performed once every 30 seconds with *i* starting at 0 and advancing through each of up to 20 unique MDA presets. *i* only advances once the preset has been met. Note that a, b, and c are the same for each of the unique presets. Only the ROI range and the

MDA preset change when *i* advances. Once *i* reaches 20 or $MDAPreset_i$ equals 0, the acquisition terminates.

SET_MDA_PRESET MDAPreset,[PeakNumber]
Sets the MDAPreset PeakNumber value as shown in the equation in the SET_MDA_COEF description above. MDAPreset is usually the product of the desired MDA, the yield and the efficiency. PeakNumber is a parameter that specifies which of up to 20 (0–19) MDA presets to change. If PeakNumber is omitted in the set command, all MDA preset values will be set to 0 (disabled), and the supplied value will be applied to MDA Preset 0. This provides compatibility software that only supports the one-nuclide MDA method implemented in some MCBs.

SET_MODE_LIST
Sets the DSPEC 50 to list mode. See also SHOW_MODE.

SET_MODE_PHA
Sets the mode to PHA.

SET_MODE_SAMPLE
Starts the InSight Virtual Oscilloscope mode.

SET_MODE_ZDT mode
Sets the ZDT mode. LIST_MODE_ZDT can be used to determine which modes are valid. Mode 0 (standard) indicates that a normal and corrected spectrum should be stored. Mode 1 (enhanced) indicates that an error and a corrected spectrum should be stored. ENABLE_ZDT must be issued to turn on ZDT mode.

SET_OUTPUT [port, value]
This sends the value to the port. This command can be issued without entries for port and value because the DSPEC 50 has only one port. If you wish to specify a port number, it must be zero for this unit. See also SHOW_OUTPUT. See also STEP_OUTPUT.

SET_OUTPUT_HIGH [output-num]
Sets the Change Sample output to the high level. The DSPEC 50 has only one sample-changer BNC, therefore, if you include a value for output-num, it must be zero (output-num is provided for compatibility with other ORTEC instruments). See also STEP_OUTPUT.

SET_OUTPUT_LOW [output-num]
Sets the Change Sample output to the low level. The DSPEC 50 has only one sample-changer BNC, therefore, if you include a value for output-num, it must be zero (output-num is provided for compatibility with other ORTEC instruments). See also STEP_OUTPUT.

SET_PEAK_PRESET count

Sets the ROI peak preset to the specified count. During data acquisition when the contents of any channel of a device that has the ROI flag set reaches the peak preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI peak may exceed the preset value by a small number of counts due to the pipelined architecture of the DSPEC 50. Setting a peak preset to 0 counts disables the preset. The peak preset may be set to from 0 (disabled) to 2147483647 counts. See also CLEAR_PRESETS and SHOW_PEAK_PRESET.

Non-USB Execution Errors:

%131135083<CR>	The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_PZ num

This sets the pole zero to num, which must be between 0 and 4095. See also ENABLE_PZ_ AUTO, SHOW_PZ, and DISABLE_PZ_AUTO.

SET_ROI start_chan,number_of_chans

Sets the ROI flags for the specified channels. This command can be used multiple times to set ROI flags without affecting previously set flags. ROI flags specify channels a device that are considered for ROI integral and ROI peak presets.

SET_ROI_MDA start,numchans, [PeakNumber]

Sets the region to use to compute the gross counts in the MDA calculation. PeakNumber is an optional parameter (assumed 0 if not present) that specifies which of up to 20 (0–19) MDA Presets to change.

SET_ROI_SAMPLE num

Selects which control signals are displayed as an ROI on the captured waveform. Only a single bit can be turned on at a time. The following signals can be selected with the associated bit.

Bit 0:	Pileup reject.
Bit 1:	Negative baseline threshold.
Bit 2:	Baseline restorer gate.
Bit 3:	Positive baseline threshold.
Bit 4:	Busy.
Bit 5:	Gate.
Bit 6:	Reserved.
Bit 7:	Peak detect.
Bit 8:	Reserved.

SET_ROI_UNCERTAINTY start, chans

Sets the region to be used for the uncertainty preset calculation. See also SHOW_ROI_ UNCERTAINTY.

SET_SEGMENT

No function in the DSPEC 50; included for backward compatibility.

SET_SHAP_FLAT value

Sets the width of the flattop to value. Value is in microseconds, ranging from 0.3 μs to 2.4 μs in steps of 0.1. See also SHOW_SHAP_FLAT.

SET_SHAP_RISE value

Sets the rise time to value. Value is in microseconds, ranging from 0.8 μs to 23 μs in steps of 0.2. See also SHOW_SHAP_RISE.

SET_SHUTDOWN index

Used in conjunction with the LIST_SHUTDOWN command to set the high voltage shutdown setting. Index specifies a position in the list of legal shutdown settings which were displayed with the LIST_SHUTDOWN command.

Example:

SET_SHUT 0	Sets the SHUTDOWN to TTL.
SET_SHUT 1	Sets the SHUTDOWN to ORTEC.
SET_SHUT 2	Sets the SHUTDOWN to SMART.

SET_SHUTDOWN_ORTEC

This sets the bias shutdown mode to ORTEC.

SET_SHUTDOWN_SMART

Sets the bias shutdown mode to SMART.

SET_SHUTDOWN_TTL

This sets the bias shutdown mode to TTL.

SET_THRESHOLD_NEGATIVE value

Sets the negative threshold to value. The negative threshold is normally set automatically by the DSPEC 50. See also ENABLE_ THRESHOLD_AUTOMATIC and SHOW_ THRESHOLD_NEGATIVE.

SET_THRESHOLD_POSITIVE value

Sets the positive threshold to value. The positive threshold is normally set automatically by the DSPEC 50. See also ENABLE_THRESHOLD_AUTOMATIC and SHOW_ THRESHOLD_POSITIVE.

SET_TIME hour,min,sec

Sets the time stored in the battery backed-up system clock to the specified values. hour can be any value from 0–23; min and sec can be any value from 0–59. The current date and time are stored for a device when an acquisition is started. See also SHOW_TIME, SET_DATE, SHOW_DATE, SET_TIME_START, and SHOW_TIME_START.

Non-USB Execution Errors:

%131137085<CR>	The time could not be set due to a hardware malfunction. Hardware service might be required.

SET_TIME_ETP value

Sets the Enhanced Throughput Mode protection time, in microseconds. value ranges from 0.1 μs to 200 μs in 25-ns increments.

Example:

SET_TIME_ETP 50	Set the protection time to 50 μs.

SET_TIME_START hour,min,sec

Sets the start time to the specified values. Normally the start date and time are set automatically whenever a device is started with the START command. See also SHOW_TIME_ START, SET_DATE_START, SHOW_DATE_START, SET_DATE, and SET_TIME.

SET_TRIGGER_POLARITY polarity

This sets the polarity of the input trigger for the sample changer (which occurs on the SAMPLERDYIN BNC) to zero or 1. Zero means it is negative-edge triggered and triggers on a high-to-low transition; 1 means the trigger is positive-edged and triggers on a low-to-high transition. See also TRIGGER, ENABLE_TRIGGER, DISABLE_TRIGGER, SHOW_TRIGGER, and SHOW_TRIGGER_POLARITY.

SET_TRIGGER_SAMPLE setting

Selects the triggering source in Insight Mode. See LIST_TRIGGER_SAMP for legal trigger sources.

SET_TRUE ticks

Sets the true-time counter to the specified number of ticks. The number represents true time in units of 20 ms (50 ticks/sec). Normally this value is set by the DSPEC 50 during data acquisition. See also CLEAR_COUNTER and SHOW_TRUE.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_TRUE_PRESET ticks

Sets the true-time preset to the specified number of ticks (20 ms/tick). During data acquisition when the true-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a true-time preset to 0 ticks disables the preset. See also CLEAR_PRESETS and SHOW_TRUE_PRESET.

Non-USB Execution Errors:

%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_ULD value

This sets the upper level discriminator to value, in channels.

SET_UNCERTAINTY_PRESET percent

Sets the uncertainty preset to the specified value in percent. Percent is a floating point value from 0–99.9999. See also SHOW_UNCERTAINTY_PRESET.

SET_WINDOW [start, length]

Sets the window of interest to the specified start channel and number of channels. The channels of spectral data in the window of interest are affected by commands such as CLEAR and SET_DATA. If neither start nor length is provided, the window is set to the maximum size allowed by the conversion gain specified. The window of interest is always set to the maximum size after a SET_DEVICE command or a SET_SEGMENT command.

Non-USB Execution Errors:

%131128085<CR> The start channel was higher than the conversion gain.

%131129086<CR> The length specified one or more channels that were too high conversion gain.

%131132080<CR> The start channel was specified without a length. If one value is given, the other must also be given.

SET_ZERO_ADJUSTMENT value

Sets the zero stabilization adjustment to an arbitrary value from −65535 to 65535. The total range of the adjustment value represents ±256 channels. This adjustment is usually only made by the gain stabilizer, and reset to 0 with the INITIALIZE_ZERO_ STABILIZATION command. See also SHOW_ZERO_ADJUSTMENT.

SET_ZERO_CHANNEL chan

Sets the center channel for the stabilizer zero peak. If a zero channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel, as determined by the conversion gain, the zero peak width is reduced until the peak fits the device boundaries. A zero channel and width must be set before zero stabilization can be enabled. See also ENABLE_ZERO_STABILIZATION.

Non-USB Execution Errors:

%131128085<CR>	The specified channel number would create a peak that was less than the minimum width (3 channels) or would be outside the device's range.
%131136084<CR>	The command was attempted while zero stabilization was enabled.

SET_ZERO_WIDTH chans

Sets the width in channels for the stabilizer zero peak. The zero width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The zero channel and width must be set before zero stabilization can be enabled. The absolute minimum width for the zero peak is 3 channels, and the absolute maximum width for the zero peak is 256 channels in Gauss mode. In point mode there is no maximum peak width, though the chosen width must allow the peak to fit within the device's channel limits as stated above.

Non-USB Execution Errors:

%131128085<CR>	The specified number of channels would create a peak that was less than the minimum width (3 channels) or would be outside the devices range.
%131136084<CR>	The command was attempted while zero stabilization was enabled.

SHOW_ACTIVE

Returns a 1 if the DSPEC 50 is active (i.e., acquiring spectral data) or 0 if it is not active.

Responses:

$C00000087<CR>	Not active.
$C00001088<CR>	Active.

SHOW_BLRE

Shows the baseline restorer time constant in microseconds. See also SET_BLRE.

Responses:

BLUE 000000000000091	Time constant is 91 μs.

SHOW_BLRE_AUTOMATIC

Shows whether automatic selection of the baseline restorer constant is off or on.

Responses:

$IT<CR> Automatic baseline is enabled.

$IF<CR> Automatic baseline is disabled.

SHOW_CONFIGURATION

Returns a record that indicates the hardware configuration of the MCB. The record contains information about the number of segments in an MCB device (always 1 for the DSPEC 50), and the current conversion gain for each segment. The record is organized as follows:

$J1638400001aaaaa00000[65 zeros here for total of 75 zeros]00000ccc

where **aaaaa** represents the conversion gain for the one and only segment in the currently selected device, and **ccc** represents the record checksum. See the section on response records in this chapter for more information about response records and checksums.

SHOW_CONFIGURATION_MASK

Returns two masks, the first of which can be "anded" with data from the MCB to clear the ROI bit from the data. When the second mask value is "anded" with data from the MCB, the data bits are removed and only the ROI bit remains.

Response:

CONF_MASK 02147483647 02147483648

SHOW_CORRECTION_FLAT

Shows the flattop correction value. See also SET_CORR_FLAT.

Responses:

CORR_FLAT 000000000000000

SHOW_CRM

Returns the current reading of the count-rate meter.

Response:

$G0000050781096 Current input count rate is 50781 counts/s.

SHOW_DATA_APPLICATION "string"

If string matches "string1" in a previous SET_DATA_APPLICATION command, then string2 from that command is returned. The response is a $F record.

Non-USB Execution Errors:

%131138085<CR> The specified string could not be matched.

SHOW_DATE

Returns the day, month, and year of the current date as maintained in the battery-backed-up real time clock, in the form dddmmmyyy. The day is returned as a 3-digit integer number from 001 to 031, month as a 3-digit integer number from 001 to 012, and year as a 3-digit integer number from 000 to 099. See also SET_DATE_START.

Responses:

$N001001088052<CR>	Date reported as Jan 1, 1988.
...	**...**
$N031012099059<CR>	Date reported as Dec 31, 1999.
$N001001000036<CR>	Date reported as Jan 1, 2000.
...	**...**
$N031012087056<CR>	Date reported as Dec 31, 2087.

SHOW_DATE_START

Returns the day, month and year of the acquisition start date in the form dddmmmyyy. The day is returned as a 3-digit integer number from 001–031, month as a 3-digit integer number from 001–012, and year as a 3-digit integer number from 000–099. See also SET_DATE_START.

Responses:

$N001001088052<CR>	Date reported as Jan 1, 1988.
...	**...**
$N031012099059<CR>	Date reported as Dec 31, 1999.
$N001001000036<CR>	Date reported as Jan 1, 2000.
...	**...**
$N031012087056<CR>	Date reported as Dec 31, 2087.

SHOW_DELAY_COLLECTION

Shows the width of the PUR signal setting. See also SET_DELAY_ COLLECTION.

Responses:

DEL_COLL 0000000000001.6

SHOW_DELAY_SAMPLE

Shows the Delay Sample setting. See also SET_DELAY_SAMPLE.

Responses:

$C00003090	The sample number is 00003, and 090 is the checksum.

SHOW_DET_SNUM

This command responds with the detector serial number stored in the SMART-1 DIM.

Response:

$FP40175	Serial number P40175.

SHOW_DET_VERSION

Returns the DIM firmware version (if a DIM is connected).

Examples:

$FNAID000	NaI DIM firmware version.
$FSMDT000	SMART-1 firmware version.

SHOW_DEVICE

Shows the currently selected device. Always 1 for DSPEC 50.

SHOW_DISPLAY

No function in the DSPEC 50; included for backward compatibility.

SHOW_ETP

Reports if Enhanced Throughput Mode is enabled.

Responses:

$IF	Enhanced Throughput Mode disabled.
$IT	Enhanced Throughput Mode enabled.

SHOW_FEATURES

Responds with four 32-bit masks indicating which features are present in the MCB. See Section 5.2 for a complete description of each bit in the mask.

Example Response:

FEATURES 02268854591 01083068428 00790633872 00002162911

SHOW_GAIN_ADJUST

Returns the gain-stabilizer amplifier setting.

SHOW_GAIN_CHANNEL

Reports the current center channel for the stabilizer gain peak. See also SET_GAIN_CHANNEL.

Responses:

$C00000087<CR>	Gain channel has not been set.
$C00002089<CR>	Gain channel is channel 2 (lowest possible channel).
...	**...**
$C16382107<CR>	Gain channel is channel 16382 (highest possible channel).

SHOW_GAIN_COARSE

Returns the coarse gain for the DSPEC 50 internal amplifier. In operation, the resulting signal gain is the product of the coarse gain, the fine gain, and the super-fine gain (used by stabilizer). The coarse gain is returned in terms of an integer gain multiplier.

Responses:

$C00001088<CR>	Coarse gain reported as 1.
$C00002089<CR>	Coarse gain reported as 2.
$C00004091<CR>	Coarse gain reported as 4.
$C00008095<CR>	Coarse gain reported as 8.
$C00016094<CR>	Coarse gain reported as 16.
$C00032092<CR>	Coarse gain reported as 32.
$C00064097<CR>	Coarse gain reported as 64.
$C00128098<CR>	Coarse gain reported as 128.

SHOW_GAIN_CONVERSION

This command returns the conversion gain.

Responses:

$C00512095<CR>	Conversion gain reported as 512 channels.
$C01024094<CR>	Conversion gain reported as 1024 channels.
$C02048101<CR>	Conversion gain reported as 2048 channels.
$C04096106<CR>	Conversion gain reported as 4096 channels.
$C08192107<CR>	Conversion gain reported as 8192 channels.
$C16384109<CR>	Conversion gain reported as 16384 channels.

SHOW_GAIN_FINE

Returns the current fine gain setting. See SET_GAIN_FINE.

Sample Response:

GAIN_FINE 000000.70000203	Fine gain is set to 0.7.

SHOW_GAIN_POLARITY

Returns the polarity of the amplifier input as $F records.

Responses:

$FNEG<CR>	The amplifier input is set to negative.
$FPOS<CR>	The amplifier input is set to positive.

SHOW_GAIN_STABILIZATION

Reports the state of gain peak stabilization. See also ENABLE_GAIN_STABILIZATION and DISABLE_GAIN_STABILIZATION.

Responses:

$IT<CR>	Gain stabilization is currently enabled.
$IF<CR>	Gain stabilization is currently disabled.

SHOW_GAIN_WIDTH

Reports the current width for the stabilizer gain peak. See also SET_GAIN_WIDTH, SET_GAIN_CHANNEL, and SHOW_GAIN_CHANNEL.

Responses:

$C00001088<CR>	Gain width has not been set.
$C00003089<CR>	Gain width is 3 channels (lowest possible width).
...	**...**
$C00256100<CR>	Gain width is 256 channels (highest possible width in Gauss mode).

SHOW_GATE

Reports the current mode of operation of the ADC gate input. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SET_GATE_ANTICOINCIDENT.

Responses:

$FOFF<CR>	Reports the ADC gate is off or ignored.
$FCOI<CR>	Reports the ADC gate is in coincident mode.
$FANT<CR>	Reports the ADC gate is in anticoincident mode.

SHOW_HV

Reports the current high voltage and the status of the high voltage power supply in the form

$Dvvvvvssssccc.

Where vvvvv represents the current output voltage if the high voltage is enabled, or the rear-panel high voltage setting if the high voltage is disabled. sssss represents the status of the high voltage bias supply as a 16-bit decimal number with the following bit definitions:

Bit 0 (LSB):	Bias supply polarity (0 = positive, 1 = negative).
Bit 1:	Bias supply overload (0 = overload, 1 = normal).
Bit 2:	High voltage enabled (0 = disabled, 1 = enabled).

Example Responses:

$D0200000003077<CR>	2000 V, negative, not overloaded, disabled.
$D0200000002076<CR>	2000 V, positive, not overloaded, disabled.
$D0200000007082<CR>	2000 V, negative, not overloaded, enabled.

SHOW_HV_ACTUAL

Returns the value of HV actually on the detector.

SHOW_HV_DIM

Indicates whether HV_DIM is enabled or disabled.

SHOW_HV_HEALTH

Returns the status of the state of health for a detector connected to the DIM port, as reported by the DIM or SMART-1.

SHOW_HV_POLARITY

This returns the HV polarity defined in the DIM as a $F record.

Responses:

$FNEG<CR>	The HV is set to negative.
$FPOS<CR>	The HV is set to positive.

SHOW_HV_RECOMMEND

Returns HV in volts, in ASCII, from SMART-1 detectors.

SHOW_HV_TARGET

Under normal operation, the HV will go to this value when the HV is enabled. Reports the current HV setting (see SET_HV) and the status of the HV power supply in the form:

$Dvvvvvssssccc<CR>

where **vvvvv** represents the HV setting, and **sssss** represents the status of the HV bias supply as a 16-bit decimal number with the following bit definitions:

Bit 0 (LSB):	Bias supply polarity (0 = positive, 1 = negative).
Bit 1:	Bias supply overload (0 = overload, 1 = normal).
Bit 2:	HV enabled (0 = disabled, 1 = enabled).

Example Responses:

$D0200000003077<CR>	2000 V, negative, not overloaded, disabled.
$D0200000002076<CR>	2000 V, positive, not overloaded, disabled.
$D0200000007082<CR>	2000 V, negative, not overloaded, enabled.

SHOW_ID

Reports the sample ID string as was previously set by the SET_ID command.

Example Responses:

$FSite 123<CR>	ID set to “Site 123".
$FSample 123456789<CR>	ID set to “Sample 123456789".

SHOW_INPUT [0]

Reports the state of the Sample Ready input.

Responses:

$C00000087<CR>	Sample Ready input is low.
$C00001088<CR>	Sample Ready input is high.

SHOW_INTEGRAL [start_chan,number_of_chans]

Reports the sum of the specified group of spectral data channels. If start_chan and number_of_chans is not provided, SHOW_INTEGRAL reports the sum of all channels in the currently selected window that have their ROI flag set.

Responses:

$G0000000000075<CR>	Integral reported as 0.
...	**...**
$G4294967294131<CR>	Integral reported as 4294967294.
$G4294967295132<CR>	Integral reported as greater than or equal to 4294967295 (maximum reportable value).

SHOW_INTEGRAL_PRESET

Reports the current ROI integral preset value. For more information about the ROI integral preset, see SET_INTEGRAL_PRESET. See also SHOW_INTEGRAL.

Responses:

$G0000000000075<CR>	Integral preset reported as 0.
...	**...**
$G4294967295132<CR>	Integral reported as 4294967295.

SHOW_INTEGRAL_REMAINING

Reports the current ROI integral remaining value. For more information about the ROI integral remaining, see SET_INTEGRAL_REMAINING. See also SHOW_INTEGRAL.

Responses:

$G0000000000075<CR>	Integral remaining reported as 0.
...	**...**
$G4294967295132<CR>	Integral reported as 4294967295.

SHOW_LENGTH_SAMPLE

Reports the number of points in the Insight mode waveform.

Response:

$C01000088	1000 points in the waveform.

SHOW_LFR

Tells whether LFR mode is enabled.

Responses:

$IF	LFR mode disabled.
$IT	LFR mode enabled.

SHOW_LIVE

Reports the contents of the live-time counter in units of 20 ms (50 ticks/s). See also CLEAR_COUNTER and SET_LIVE.

Responses:

$G0000000000075<CR>	Live time reported as 0 ticks.
$G0000000001076<CR>	Live time reported as 1 tick (20 ms).
...	**...**
$G4294967295132<CR>	Live time reported as 4294967295 ticks (over 23000 days).

SHOW_LIVE_PRESET

Reports the current live-time preset in units of 20 ms (50 ticks/s). See also CLEAR_PRESETS and SET_LIVE_PRESET.

Responses:

$G0000000000075<CR>	Live-time preset reported as disabled.
$G0000000001076<CR>	Live-time preset reported as 1 tick.
...	**...**
$G4294967295132<CR>	Live-time preset reported as 4294967295 ticks.

SHOW_LIVE_REMAINING

Reports the current live-time remaining in units of 20 ms (50 ticks/s). See also SET_LIVE_REMAINING.

Responses:

$G0000000000075<CR>	Live-time remaining reported as disabled.
$G0000000001076<CR>	Live-time remaining reported as 1 tick.
...	**...**
$G4294967295132<CR>	Live-time remaining reported as 4294967295 ticks.

SHOW_LLD

Shows the lower level discriminator setting. See also SET_LLD.

Responses:

$C00050092	The LLD is 50.

SHOW_MDA [PeakNumber]

Reports current MDA for the MDA Preset selected by PeakNumber. PeakNumber is assumed to be 0 if not supplied.

Example response:

MDA 0000000000010.7

SHOW_MDA_COEF

Reports the current settings for coeffficients a, b, and c used for the MDA calculation. See SET_MDA_COEF.

Example Responses:
MDA_COEF 000000000002.71 000000000000000 00000021.700001
Coefficient a = 2.71, b = 0, and c = 21.7.

SHOW_MDA_PRESET [PeakNumber]
Reports MDA preset PeakNumber. If PeakNumber is omitted, 0 is assumed.
Example Response:
MDA_PRES 0000000000025.7

SHOW_MODE
Reports the current mode of operation (PHA, List, or Sample [InSight Virtual Oscilloscope]). See also SET_MODE_PHA and SET_MODE_SAMPLE.
Responses:

$FPHA<CR>	PHA mode.
$FLIS<CR>	List mode.
$FSAM<CR>	Sample mode (InSight).

SHOW_MODE_ZDT
Reports the current ZDT mode. See SET_MODE_ZDT.
Responses:

MODE_ZDT 00000	Mode 0 selected (normal and corrected).
MODE_ZDT 00001	Mode 1 selected (error and corrected).

SHOW_MONI_LABEL num
Returns with an ASCII string label designation for the SOH parameter for num.

SHOW_MONI_MAX
Returns with the number of SOH values available for viewing.

SHOW_MONI_VALUE num
Returns with an ASCII representation of the value for the SOH parameter.

SHOW_NAI
Indicates whether ENABLE_NAI has been sent. Responses are true and false.
Responses:

$IT<CR>	NaI mode enabled.
$IF<CR>	NaI mode disabled.

SHOW_NEXT
Used in conjunction with the SHOW_ROI command, SHOW_NEXT reports the next continuous group of channels that have the ROI flag set. The response is of the form:

$Dsssssnnnnnccc<CR>

where sssss represents an integer number that is the number of the first channel of the "next" group of channels that all have their ROI bit set, and nnnnn represents an integer number that is the number of channels in the group. If no more channels have their ROI bit set, SHOW_NEXT returns a first channel of 0 and a number of channels of 0. The SHOW_ROI command is used to report the "first" group of channels that all have their ROI bit set.

Example Responses:

$D0100000050078<CR>	Next ROI group starts at channel 1000 and is 50 channels long.
$D0215000150086<CR>	Next ROI group starts at channel 2150 and is 150 channels long.
$D0000000000072<CR>	No other ROI groups to report.

SHOW_OUTPUT [0]

Reports the status of the "Change Sample" output port. The output port status is reported as a 16-bit number that is 0 or 1, depending on the level last set by a SET_OUTPUT_HIGH or SET_OUTPUT_LOW command.

Responses:

$C00000087<CR>	Change Sample output currently low.
$C00001088<CR>	Change Sample output currently high.

SHOW_PEAK

This command returns the contents of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The maximum possible value is 2147483647, which is the maximum number of counts that can be stored in a 31-bit channel.

Responses:

$G0000000000075<CR>	Maximum count in an ROI channel is zero or no ROI channels were found.
$G0000000001076<CR>	Maximum count in an ROI channel is 1.
...	**...**
$G2147483646120<CR>	Maximum count in an ROI channel is 2147483646.
$G2147483647121<CR>	Maximum count in an ROI channel is 2147483647.

SHOW_PEAK_CHANNEL

This command returns the number of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The lowest number ROI channel with the largest count is reported if more that one channel contains the largest number of counts. Channel 16383 is the highest numbered channel in any device.

Responses:

$C00000087<CR>	Maximum count was found in channel 0 or no ROI channels were found.

$C00001088<CR>	Maximum count was found in channel 1.
...	**...**
$C16382107<CR>	Maximum count was found in channel 16382.
$C16383108<CR>	Maximum count was found in channel 16383.

SHOW_PEAK_PRESET

Reports the value of the ROI peak preset. See SET_PEAK_PRESET for information about the ROI peak preset.

Responses:

$G0000000000075<CR>	Peak preset disabled.
$G0000000001076<CR>	Peak preset set to 1 count.
$G2147483646120<CR>	Peak preset set to 2147483646 counts.
$G2147483647121<CR>	Peak preset set to 2147483647 counts.

SHOW_PZ

Displays the PZ setting. See also SET_PZ.

Responses:

PZ_ENA 002200	Pole zero enabled and set to 2200.
PZ_DIS 001000	Pole zero disabled and set to 1000.

SHOW_PZ_AUTOMATIC

Shows the state of the automatic PZ. See also SET_PZ_AUTOMATIC.

Responses:

$IT<CR>	Pole zero enabled.
$IF<CR>	Pole zero disabled (TRP).

SHOW_RENH

Reports if Resolution Enhancer mode is enabled.

Responses:

$IF	Resolution Enhancer mode disabled.
$IT	Resolution Enhancer mode enabled.

SHOW_ROI

Used in conjunction with the SHOW_NEXT command, SHOW_ROI reports the first continuous group of channels that have the ROI flag set. The response is of the form:

$Dsssssnnnnnccc<CR>

where sssss represents an integer number that is the number of the first channel of the "first" group of channels that all have their ROI bit set, and nnnnn represents an integer number that is the number of channels in the group. The SHOW_NEXT command is used to report the "next" group of channels that all have their ROI bit set.

Responses:

$D0100000050078<CR> First ROI starts at channel 1000 and is 50 channels long.
$D0215000150086<CR> First ROI starts at channel 2150 and is 150 channels long.
$D0000000000072<CR> No ROI groups to report.

SHOW_ROI_MDA

Reports the start channel and number of channels used in the MDA preset calculation.
Example Response:
$D0700000050ccc Calculation is performed on channels 7000–7049.

SHOW_ROI_SAMPLE

Displays the ROI Sample setting. See also SET_ROI_SAMPLE.
Responses:
$C00001088

SHOW_ROI_UNCERTAINTY

Reports the start channel and number of channels used in the uncertainty preset calculation. See also SET_ROI_UNCERTAINTY.
Response:
$D0700000050ccc Calculation is performed on channels 7000–7049.

SHOW_SEGMENT

Returns the current segment number. Always 1 for the DSPEC 50.

SHOW_SHAP_FLAT

Reports the width of the flattop in μs. See also SET_SHAP_FLAT.
Responses:
SHAP_FLAT 0000000000001.2

SHOW_SHAP_RISE

Displays the rise-time setting in μs. See also SET_SHAP_RISE.
Responses:
SHAP_RISE 0000000000003.2

SHOW_SHUTDOWN

Shows the type of HV shutdown selected.
Responses:
$FORT ORTEC mode selected.
$FTTL TTL mode selected.
$FSM1 SMART-1 mode selected

SHOW_SHUT_ACTUAL

Returns the current status of the bias remote shutdown input signal. This command is valid whether the bias supply is turned on or off.

Responses:

$IT	Shutdown is active (supply is shut down or can't be turned on).
$IF	Shutdown is inactive (supply is on or can be turned on).

SHOW_SNUM

Responds with a $F record indicating the serial number of the DSPEC 50

Response:

$F100	Serial number = 100.

SHOW_STATUS

Returns system status information in the following format:

$Mlllllllllltttttttttaaaaahhhhhccc<CR>

where **lllllllllll** represents the live time as returned by the SHOW_LIVE command, **ttttttttt** represents the true time for the current device as returned by the SHOW_TRUE command, **aaaaa** represents the active device mask as returned by the SHOW_ACTIVE_DEVICES command, and **hhhhh** represents the hardware status, which is an ASCII representation of a 16 bit decimal number with the following bit definitions:

Bit 0 (LSB):	Bias supply polarity (0=positive, 1=negative)
Bit 1:	Bias supply overload (0=overload, 1=normal)
Bit 2:	High voltage enabled (0=disabled, 1=enabled)
Bit 3:	Unused
Bit 4:	Amplifier PZ'd since initialization (0=normal, 1=needs PZ'ing)
Bit 5	Optimization since initialization (0=normal, 1=needed)
Bits 6–7:	Unused
Bit 8:	Amplifier automatic PZ (1=Auto PZ in progress, 0=normal)
Bit 9:	Optimization (0=normal, 1=in progress)
Bits 10–14:	Unused
Bit 15 (MSB):	Reserved

SHOW_THRESHOLD_AUTOMATIC

See also SET_THRESHOLD_AUTOMATIC.

Responses:

$IT<CR>	Automatic threshold is enabled.
$IF<CR>	Automatic threshold is disabled.

SHOW_THRESHOLD_NEGATIVE

See also SET_THRESHOLD_NEGATIVE.

Responses:

THR_NEG 0000379791 Negative threshold is 379791.

SHOW_THRESHOLD_POSITIVE

See also SET_THRESHOLD_POSITIVE.

Responses:

THR_POS 00000126811 Positive threshold is 126811.

SHOW_TIME

Reports the time from the battery backed-up system clock in the form:

$Nhhhmmmssccc<CR>

where hhh represents a 3-digit integer hour (0–23), mmm represents a 3-digit integer minute (0–59), and sss represents a 3-digit integer second (0–59). See also SET_TIME, SET_DATE, and SHOW_DATE.

Example Responses:

$N010054017052<CR> Time returned 10:54:17 (10 h, 54 min, 17 s).

$N020013037050<CR> Time returned 20:13:37 (20 h, 13 min, 37 s).

SHOW_TIME_ETP

Returns the current Enhanced Throughput Mode protection time.

Response:

TIME_ETP 0000000000012.8 Protection time is set to 12.8 μs.

SHOW_TIME_START

Reports the time of the last START command in the form

$Nhhhmmmssccc<CR>

where hhh represents a 3-digit integer hour (0 through 23), mmm represents a 3-digit integer minute (0 through 59) and sss represents a 3-digit integer second (0 through 59). See also SET_TIME_START, SET_DATE_START, and SHOW_DATE_START.

Example Responses:

$N010054017052<CR> Time returned 10:54:17 (10 h, 54 min, 17 s).

$N020013037050<CR> Time returned 20:13:37 (20 h, 13 min, 37 s).

SHOW_TRIGGER

Tells whether the trigger is enabled or disabled. See also ENABLE_TRIGGER.

Responses:

$IF Trigger disabled.

$IT Trigger enabled.

SHOW_TRIGGER_POLARITY

This returns the polarity setting of the input trigger for the sample changer (1 means the trigger is positive-edged and triggers on a low-to-high transition; 0 means it is negative-edge triggered and triggers on a high-to-low transition). See also TRIGGER, ENABLE_ TRIGGER, DISABLE_TRIGGER, SHOW_TRIGGER, and SET_TRIGGER_POLARITY.

Responses:

$FNEG<CR>	The HV is set to negative.
$FPOS<CR>	The HV is set to positive.

SHOW_TRIGGER_SAMPLE

Reports the trigger source in Insight Mode.

Responses:

$F0LLD	LLD is source.
$F1PKD	Peak-detect is source.
$F2RANDOM	Trigger happens randomly.
$F3Gate	Gate Input triggers the waveform.

SHOW_TRUE

Reports the contents of the true-time counter in units of 20 ms (50 ticks/s). See also CLEAR_COUNTER and SET_TRUE.

Responses:

$G0000000000075<CR>	True time reported as 0 ticks.
$G0000000001076<CR>	True time reported as 1 tick (20 ms).
...	**...**
$G4294967295132<CR>	True time reported as 4294967295 ticks (over 23000 days).

SHOW_TRUE_PRESET

Reports the current true-time preset in units of 20 ms (50 ticks/s). See also CLEAR_PRESETS and SET_TRUE_PRESET.

Responses:

$G0000000000075<CR>	True time preset reported as disabled.
$G0000000001076<CR>	True time preset reported as 1 tick.
...	**...**
$G4294967295132<CR>	True time preset reported as 4294967295 ticks.

SHOW_TRUE_REMAINING

Reports the current true time remaining in units of 20 milliseconds (50 ticks per second). See also SET_TRUE_REMAINING.

Responses:

$G0000000000075<CR>	True time remaining reported as disabled.
$G0000000001076<CR>	True time remaining reported as 1 tick.
...	**...**
$G4294967295132<CR>	True time remaining reported as 4294967295 ticks.

SHOW_ULD

Returns the value of the ULD in channels, as a $C record.

SHOW_UNCERTAINTY

Returns the current value of the uncertainty for the peak in the uncertainty preset. See also SET_UNCERTAINTY.

Responses:

UNCE 0000000000008.5	Uncertainty of the peak is 8.5%.

SHOW_UNCERTAINTY_PRESET

Returns the current uncertainty preset setting. See also SET_UNCERTAINTY_PRESET.

Responses:

UNCE_PRES 000000000000000	No preset.
UNCE_PRES 0000000000008.5	Preset set to 8.5%.

SHOW_VERSION

Reports the DSPEC 50 firmware version number in the form

Fmmmm-vvv<CR>

where mmmm is a 4-character model designator and vvv is a 3-character version designator.

Example Responses:

$FDS50–003<CR>	Model DSPEC 50 firmware version 3 reported.

SHOW_WINDOW

Reports the start channel and number of channels in the window of interest, in the form

$Dxxxxxyyyyyccc<CR>

where xxxxx is the start channel (0–16383) and yyyyy is the number of channels (1–16384). See SET_WINDOW for more information about the window of interest.

Example Responses:

$D0000016384094<CR>	Window of interest reported as starting at channel 0 and continuing for 16384 channels.
$D0000008192092<CR>	Window of interest reported as starting at channel 0 and continuing for 8192 channels.
$D0819208192112<CR>	Window of interest reported as starting at channel 8192 and continuing for 8192 channels.

SHOW_ZDT

Reports if ZDT mode is enabled.

Responses:

$IF	ZDT mode disabled.
$IT	ZDT mode enabled.

SHOW_ZERO_ADJ

Returns the value of the zero offset for the zero stabilizer.

SHOW_ZERO_CHANNEL

Reports the center channel for the stabilizer zero peak. See also SET_ZERO_CHANNEL, SET_ZERO_WIDTH, and SHOW_ZERO_WIDTH.

Responses:

$C00000087<CR>	Zero channel has not been set.
$C00002089<CR>	Zero channel is channel 2 (lowest possible channel).
$C16382107<CR>	Zero channel is channel 16382 (highest possible channel).

SHOW_ZERO_STABILIZATION

Reports the state of zero peak stabilization. See also ENABLE_ZERO_STABILIZATION and DISABLE_ZERO_STABILIZATION.

Responses:

$IT<CR>	Zero stabilization is currently enabled.
$IF<CR>	Zero stabilization is currently disabled.

SHOW_ZERO_WIDTH

Reports the current width for the stabilizer zero peak. See also SET_ZERO_WIDTH, SET_ZERO_CHANNEL, and SHOW_ZERO_CHANNEL.

Responses:

$C00001088<CR>	Zero width has not been set.
$C00003089<CR>	Zero width is 3 channels (lowest possible width).
$C00256100<CR>	Zero width is 256 channels (highest possible width in Gauss mode).
$C16383108<CR>	Zero width is 16383 channels (highest possible width in point mode with zero channel set to 8192).

START [seg-mask]

Starts the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored by the DSPEC 50.

Execution Warnings:

%000004073<CR> No segment selected (occurs with other warnings).
%000005074<CR> The acquisition is already started (no changes made).
%000006075<CR> A preset was exceeded (acquisition was not started).
%000008073<CR> Unit not optimized since initialization.
%000016076<CR> Amplifier not PZ'd since initialization.
%000032074<CR> High voltage is disabled.

The actual response record may be a combination of any of the above records depending on the warning conditions. For example:

%000048081<CR> Amplifier not PZ'd and high voltage disabled.

START_OPTIMIZE

Starts optimization of PZ and flattop correction for all rise times.

START_PZADJUST_AUTO

Starts the automatic PZ process. The automatic PZ is not complete until indicated by the auto PZ status bit. This bit is returned by the SHOW_STATUS command. Spectral data can be corrupted if automatic PZ is initiated while a device is collecting data.

Non-USB Execution Errors:

%131136084<CR> The command was attempted while the amplifier was set for a transistor reset preamplifier. No action was taken.

STEP_OUTPUT

Causes a pulse to be output on the Change Sample output port. The level of the Change Sample output is changed then returned to the level present when the STEP_OUTPUT command was received. The duration of the intermediate level varies but is never less than 2 μs. Use the SET_OUTPUT_HIGH or SET_OUTPUT_LOW commands to establish an initial output level.

Responses:

$C00000087<CR> Initial and final level on Change Sample was low.
$C00001088<CR> Initial and final level on Change Sample was high.

STOP [seg-mask]

Stops the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored.

Non-USB Execution Warnings:

%000005074 Acquisition already stopped (no changes made).

STOP_OPTIMIZE

Stops the optimization in progress. The DSPEC 50 may be in an indeterminate mode. See also START_OPTIMIZE.

STOP_PZ_AUTOMATIC

Stops the optimization in progress. The DSPEC 50 may be in an indeterminate mode. See also START_PZ_AUTOMATIC.

TERM

No function in the DSPEC 50; included for backward compatibility.

TRIGGER

Starts data acquisition if the trigger has been enabled (ENABLE_TRIGGER).

VERIFY_CORR_FLAT
VERIFY_SHAP_FLAT
VERIFY_SHAP_RISE

These test the argument against the list of valid settings and return true if valid.

APPENDIX A. STATIC IP ADDRESSING

A.1. Preliminary Notes on IP Addresses and Subnet Masks

All devices (computers, DSPEC 50s, printers, etc) on a network must have a unique TCP/IP address (IP address). If the same address is assigned to multiple devices, communication errors will occur. IP version 4 addresses are formatted as four bytes (four sections, each containing a number between 0 and 255) separated by a decimal point (**.**).

The other setting necessary for network communication is the *subnet mask*, which is formatted the same as the IP address. The subnet mask defines which devices can communicate with each other on the network. In order to communicate, two devices must have identical IP addresses in the bits defined by the subnet mask. As an example, assume the following devices are on the network:

Device	**IP Address**	**Subnet Mask**
Computer	10.7.3.3	255.255.0.0
Printer	10.8.3.3	255.255.0.0
DSPEC 50	10.7.3.4	255.255.0.0

All IP addresses on the list are unique; this is the minimum requirement for successful communication. However, we must also examine the subnet mask setting.

In the subnet mask 255.255.0.0, the first two bytes (sections) have all the bits set. This means that, in order for two devices to communicate with each other, the first two bytes of their IP addresses must match.

Note that the first two bytes (sections) in the computer and DSPEC 50 IP addresses match. However, the printer's second byte is different. As a result, the computer and the DSPEC 50 can communicate, but the printer cannot.

A.2. Assigning Static IP Addresses

1. Power on the first of your DSPEC 50s, open the Communication Control screen, then do the following:

   — Tap **Defaults** to retrieve the factory default IP address and subnet mask.

   — Tap **Use the following IP address**.

   The resulting Communication Control screen will resemble Fig. 45.

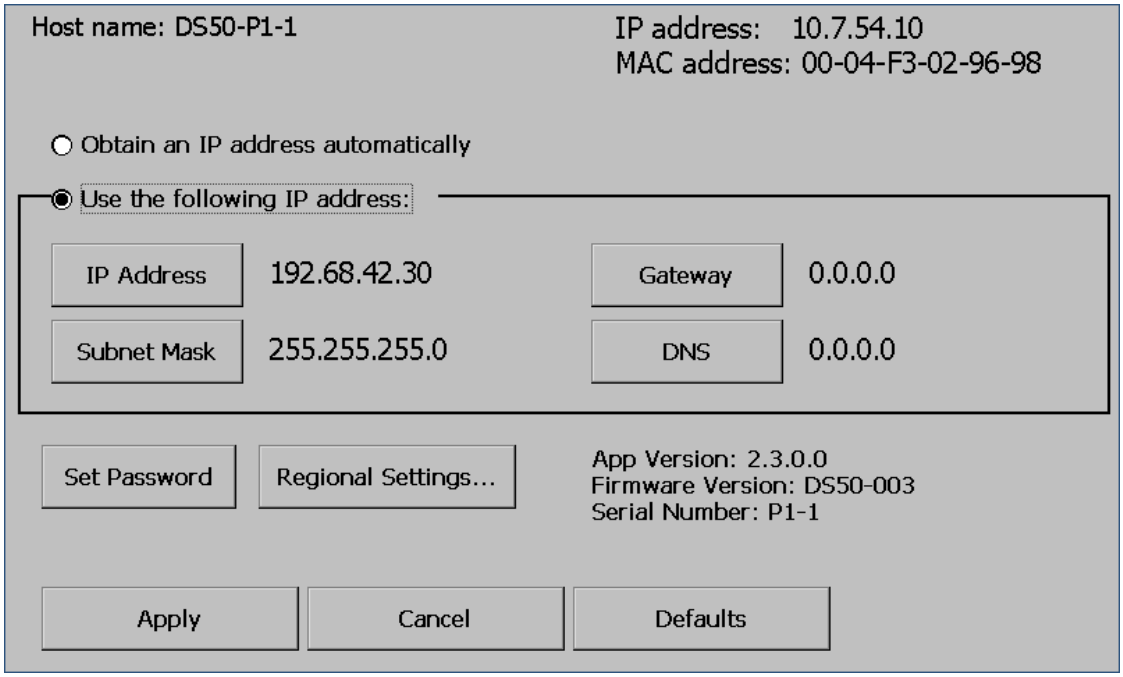


Figure 45. Static IP Addressing: Tap the "Defaults" Button, Then "Use the following IP Address," Then "Apply."

2. For the first DSPEC 50, the factory default IP address and subnet mask can be used as-is. Tap **Apply** to close the Communication Center dialog.

   To assign a different IP address, tap the **IP Address** button. This will open a soft keyboard over the bottom section of the screen. Tap the soft keyboard digits, separating each of the four sections by tapping the "decimal point" button (**.**) button.

   IMPORTANT Do not enter leading zeroes in any of the four sections (e.g., enter `10`, not `010`). Also, be sure to insert the decimal-point demarcator between sections.

   Tap **OK** to accept the completed IP address, then tap **Apply** to close the Communication Center dialog.

   As noted above, the same **Subnet Mask** *must* be assigned to the computer and all DSPEC 50s that will communicate with it. If the DSPEC 50's subnet mask does not match the mask assigned to the computer, tap **Subnet Mask** and change the DSPEC 50 subnet mask to match the computer setting.

3. Connect the DSPEC 50 to the Ethernet port on the host computer, open the computer's **Network Connections** utility, and assign a (version 4) IP address that does not match any address currently in use, and is valid according to Section A.1.

4. If this is the only DSPEC 50 that will be connected to the computer, run the MCB Configuration program (Section 3.5, page 35). If MCB Configuration does not locate the DSPEC 50, a conflict may be occurring. Unplug the DSPEC 50 Ethernet connection, PING the IP address assigned to the DSPEC 50, and verify that no other device responds to the PING. If a device does respond, choose a new address for the DSPEC 50 and try again. See also Sections A.1 and B.2 or consult your IT department.

5. Each subsequent DSPEC 50 must have a unique, valid IP address; and its subnet mask must match the computer's. When all have been set up and connected, run the MCB Configuration program (Section 3.5, page 35).

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APPENDIX B. TROUBLESHOOTING

B.1. MAESTRO Does Not Connect with the DSPEC 50

If properly installed and functioning MAESTRO software (or other CONNECTIONS programs) cannot find and communicate with the DSPEC 50, check for the following:

- The DSPEC 50 is not turned on.
- The Ethernet or USB cable is not properly connected.
- The Ethernet switch or USB hub is not powered on and communicating.
- DSPEC 50s are connected to the same computer via both Ethernet and USB connections. All DSPEC 50s on the same computer must use only one of the connection methods (See Section 3.4.)
- A locally connected DSPEC 50 was switched from the USB port to the Ethernet port, or vice versa, without re-running MCB Configuration.
- For DSPEC 50s connected to the same computer via Ethernet and assigned static IP addresses, ensure the computer and all DSPEC 50s are using the same Subnet Mask and that each is assigned a valid IP address. See Section B.2.
- For networked DSPEC 50s with static IP addresses, each must have a valid IP address. See Section B.2, and keep in mind that no two adapters in the system can have the same significant bits in their IP address. (Usually this means if the subnet has 255 in one of its groups, that group is significant. The actual calculation is to do a bitwise AND operation between the IP address and the subnet mask and compare the results.) Consult your site's IT personnel or contact our Global Service Center.
- Check the Master Instrument List on the computer to ensure that the DSPEC 50 is on the list. If it is not listed, shut down and restart the computer, cycle the DSPEC 50 power, then rerun the MCB Configuration program *being sure not to use the -L switch*. See Section 3.5 for more information on using MCB Configuration.
- If you cannot access the DSPEC 50 across a network, make sure the MCB Server (MCBSer32.exe) and MCB Sockets Server (MCBServerNX.exe) programs are running on the unit's host computer.

For further assistance, contact your ORTEC representative or our Technical Services Group.

B.2. Troubleshooting Static IP Addresses

If you are unable to configure an Ethernet-connected DSPEC 50 that has a static IP address, the most likely reason is that the system is already using the IP address you are trying to assign. We recommend that your system administrator or IT staff troubleshoot the problem. See also Appendix B. Note that the IPCONFIG and PING commands run from the command prompt.

- Run IPCONFIG to return a list of network adapters for your system along with the IP address and subnet mask for each. If the DSPEC 50's subnet mask doesn't match the computer's, change the DSPEC 50 subnet mask to match.

- Assign the DSPEC 50 an IP address that does not match any address currently in use. If you suspect a conflict is occurring, unplug the DSPEC 50 Ethernet connection, PING the IP address which has been assigned to the DSPEC 50, and verify that no other device responds to the PING. If a device does respond, choose a new address for the DSPEC 50 and try again.

- PING the new IP address to confirm it is correctly configured.

B.3. Lost Password

If you lose the password to the Communication Settings and Data Display screens, you must reset it as follows.

- Insert paper clip into the rear-panel RESET hole, located immediately above the SD card slot. Press it in and hold it while cycling the power off/on. When the DSPEC 50 restarts, cycle the power off/on once again to return the unit to normal operation.

- If you perform this operation with MAESTRO running, wait until after the second off/on cycle, cancel the "Unknown Mode," then close and reopen the DSPEC 50 detector window. If your detector uses a DIM, MAESTRO may display a bad state-of-health message due to the power interruption. Click the "ignore" option. The DSPEC 50 is now ready for use.

APPENDIX C. STATE-OF-HEALTH BIT DEFINITIONS

Following are descriptions of the SOH bit. To monitor these within MAESTRO, click **Acquire/ MCB Properties...**, then on the Status tab (see Fig. 46).

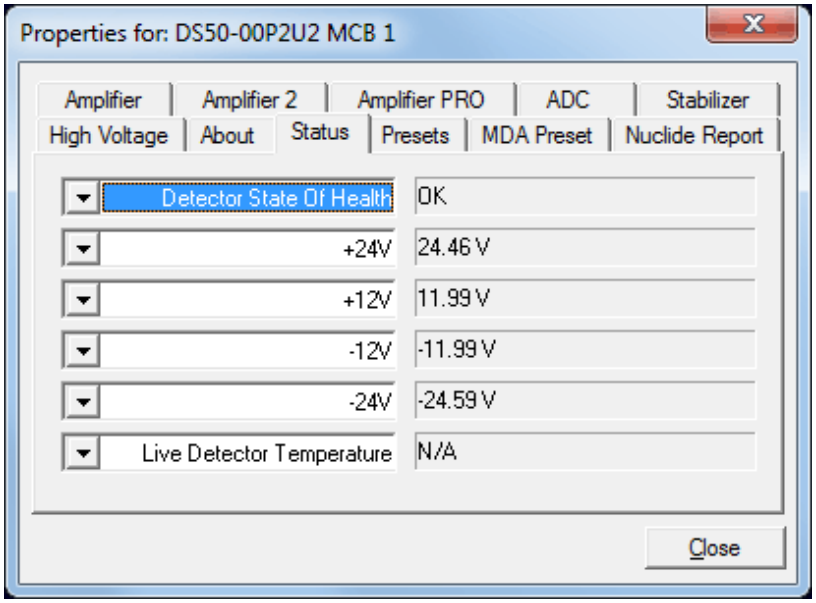

Figure 46. The SOH Status Tab Under MCB Properties.

Bit	Description	Comment
0	+24V	
1	+12V	The first four bits monitor the voltages coming from the DSPEC 50. If one of these values varies by more than ±2 V, the corresponding bit is set.
2	−12 V	
3	−24V	
4	Temperature	Set if the detector temperature increases and shuts down the HV (therefore, the SHUTDOWN bit will also be set).
5	HV voltage	Set if the high voltage deviates by more than ±300 V from the value you entered in MAESTRO.
6	Overload	Set if the preamplifier overloads for more than about 4.0 seconds.
7	Shutdown	Set if the preamplifier shuts down for any reason.

Bit	Description	Comment
8	Security	At the start of the acquisition, the DSPEC 50 queries the SMART-1 HPGe detector for its serial number. The DSPEC 50 then writes a random number to the SMART-1 HPGe detector. At the end of the acquisition, both numbers are read from the SMART-1 HPGe detector and compared to the original values. If there is a mismatch, the Security SOH bit is set.
9	Power	Set if the power fails during an acquisition.

APPENDIX D. CALCULATIONS

D.1. The Nuclide Report

The Nuclide Report displays the activity of up to 9 user-selected peaks. Once the report is set up you can view the Nuclide Report at any time. The peak area calculations are the same as the calculations in MAESTRO and other ORTEC software, so the Report contents can be duplicated using the spectra stored in the computer. The calculated value is computed by multiplying the net peak count rate by a user-defined constant. If the constant includes the efficiency and branching ratio, the displayed value will be activity. The nuclide label and the activity units are entered by the user.

The report has this format:

Nuclide	keV	uCi/m2	±%
CO-60	1332.5	1.21E+01	10.2
CO-60	1173.2	1.09E+01	12.3
CO-57	122.1	1.48E+00	86.2

D.1.1. Calculations

These are the calculations used to generate the Nuclide Report's **Activity**, **Uncertainty**, and **Peak** values.

Activity is calculated as follows:

$$Activity = \frac{NetCounts \cdot NucCoef}{LiveTime}$$

NucCoef is normally the inverse of efficiency times the branching ratio. Note that the efficiency is the ABSOLUTE counting efficiency for the source-detector geometry being used. Thus, in order to get meaningful activity results, as in any counting situation, you need to have efficiency factors which are appropriate to the actual counting geometry. If *NucCoef* is set to 1, you will get peak count rate on the display.

LiveTime is the current live time.

NetCounts is computed with the following equation:

$$NetCounts = GrossCounts - Background$$

GrossCounts is the sum of the counts in the ROI, excluding the first and last 3 channels of the ROI.

Background is:

$$Background = \frac{AvgCount\ first\ 3\ chan + AvgCount\ last\ 3\ chan}{2} \cdot ROIWidth$$

ROIWidth is:

$$ROIWidth = EndChannel - StartChannel + 1 - 6$$

Uncertainty (in percent) is calculated as follows:

$$Uncertainty = \frac{\sqrt{GrossCounts + Background \cdot \frac{ROIWidth}{6}}}{NetCounts} * 100$$

Peak is the position of the maximum count and is computed with the following equation:

$$Peak = MaximumROIChan * EnergySlope + EnergyIntercept$$

MaximumROIChan is the channel in the ROI with the most counts. If there are no data, the center channel of the ROI is used.

EnergySlope and *EnergyIntercept* are the energy calibration values as entered on the digiDART-LF keypad or by software. If the values are not present, the result is given in channels.

D.2. Gain and Zero Stabilization

The gain stabilizer requires a peak in the spectrum to monitor the changes in the gain of the system amplifier. The gain stabilizer controls the amplification factor of a separate amplifier so that the peak will be maintained in its original position.

The zero stabilizer enables you to control the zero-level (or offset) stabilizer. The zero-level stabilizer uses a peak in the spectrum to monitor the changes in the zero level of the system amplifier. The zero stabilizer controls the offset bias level so the peak will be maintained in its original position.

For both functions, the input pulse-height-to-channel-number relationship is:

$$Channel\ number = Intercept + Gain * pulse\ height$$

where:

Intercept = The channel number of the zero-height input pulse
Gain = The relation between pulse height and channel number (slope of the curve)

Changes in either the intercept or gain can affect the positions of all the peaks in the spectrum. When used with the zero stabilizer, both the zero intercept and the gain (slope) will be monitored to keep all the peaks in the spectrum stabilized. The zero stabilization and gain stabilization are separate functions in the DSPEC 50 but both will affect the position of the peaks in the spectrum.

The stabilization operates by keeping a peak centered in an ROI you have defined. The ROI should be made symmetrically about the center of a peak with reasonably good count rate in the higher channels of the spectrum. The ROI should be about twice the FWHM of the peak. If the region is too large, counts not in the peak will have an effect on the stabilization.

Before setting either stabilization peak, the coarse and fine gains should be set to the desired values, and optimization or pole-zero performed.

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APPENDIX E. LIST MODE IN THE DSPEC 50

The DSPEC 50 is equipped with *List Mode,* which streams spectroscopy data directly to the computer, event-by-event, without the data "dead periods" associated with the acquire-store-clear-restart cycle of standard spectrum acquisition. To enter List Mode, issue the SET_MODE_LIST command; use SET_MODE_PHA to exit List Mode.

This appendix provides details about the List Mode that will enable experienced programmers, using the ORTEC CONNECTIONS Programmer's Toolkit with Microsoft® ActiveX® Controls (A11-BW) to write custom software applications for acquiring and saving List Mode data. For additional information, see:

http://www.ortec-online.com/Solutions/applications-software.aspx?tab=2

MAESTRO v7 supports our List Mode MCBs with menu and toolbar commands, as well as commands in our automated JOB streams. See the MAESTRO user manual for detailed information.

E.1. List Mode Data

In List Mode, each detectable event that would normally be histogrammed as a spectrum is sent to the computer in the form of a pulse-height value along with a time stamp that indicates the time the pulse arrived. The data can be analyzed by the computer in real time to determine if some significant event has occurred, or can be streamed to disk for analysis at a later time. In either case, the computer is intimately involved in the collection of the data.

In List Mode, the DSPEC 50 will produce one 32-bit word for every detectable event in the detector. The 32-bit ADC event word is encoded as follows:

Bit	**Description**
31–30	`1 1` for ADC event
29–16	14-bit ADC value, i.e., amplitude of pulse
15–0	16-bit value; time that the event occurred in 200 ns ticks

The time in the ADC event word rolls over to zero every 10 ms (the maximum value is 49999). In order to track the rollovers, a real-time event is sent from the DSPEC 50 to the computer every time the ADC event time rolls over. The 32-bit real-time event word is encoded as follows:

Bit	**Description**
31–30	`1 0` for real-time event
29–0	Real time in 10 ms ticks

To determine the real-time for a given ADC event you must combine the real time from the most recent real-time event with the time from the ADC event as follows:

$$Real\ time\ in\ 200\ ns\ ticks\ =\ (Real\ time\ event\ time \times 50) + (ADC\ event\ time)$$

The DSPEC 50 sends a live-time event with every real-time event. Since the live-time events are synchronized to the real-time events, there is up to 10 ms of error in the live time reported for the event. These events are encoded as follows:

Bit	**Description**
31–30	0 1 for live-time event
29–0	Live time in 10 ms ticks

E.2. Throughput Issues

The DSPEC 50 is equipped with a 48K by 32-bit first-in-first-out (FIFO) buffer that stores events until the computer has time to read them. Should the computer stop reading data, the FIFO will fill up and all further data will be lost until the computer removes events from the FIFO. In List Mode, a 32-bit data word is inserted into the FIFO for each event received from the ADC. In extreme situations with multiple DSPEC 50s connected to a single computer, the data rate can overwhelm the computer. For example, if a source is placed in front of the detector that results in 10K ADC events per second, 10200 thirty-two-bit data words must be transferred to the computer every second. In order to retrieve all of the list data, the computer must read the data from the DSPEC 50 before the buffer fills up. In this example, the computer must read data from the DSPEC 50 at least once every 4.8 seconds to avoid overflow (10200 events per second going into the 49152-event-deep FIFO). In practice, you should plan to read more often than this in order to compensate for unexpected delays introduced by other programs running on your computer, including internal operating-system programs.

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